KATIVIK EFFICIENT ENERGY STUDY

An energy study and training program in Kuujjuak and Kangirsuk, Quebec

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An Energy Planning Study and Training Program in Kuujjuaq* and Kangirsuk**, Quebec

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Kativik Regional Government

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With contributions from:

Remote Community Demonstration Program
of Energy, Mines and Resources Canada,
Hydro-Québec,
La Société d'Habitation du Québec,
Kativik Regional Government,
Makivik Corporation

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* Formerly known as Fort Chimo
** Formerly known as Payne Bay

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GLOSSARY

EMR	Energy, Mines and Resources Canada
HQ	Hydro-Quebec
House-doctors	Name given to the trainees
Kangirsuk	Corporation of the Northern Village of Kangirsuk (Payne Bay)
KEEP	Kativik Efficient Energy Program
KRG	Kativik Regional Government. Supra-municipal government with jurisdiction over the 13 Inuit communities north of the 55th parallel in the Province of Quebec.
Kuujjuaq	Corporation of the Northern Village of Kuujjuaq (Fort-Chimo)
Makivik	Makivik Corporation. Inuit corporation with the mandate to manage the funds from the James Bay Agreement.
RCDP	Remote Community Demonstration Program
SHQ	La Société d'Habitation du Québec
SHQ Housing	The Société d'Habitation du Québec owns, builds and sponsors the Inuit houses in Northern Quebec; the Inuit pay rent to SHQ, according to the family income.
Tesiujaq	Corporation of the Northern Village of Tesiujaq (Leaf Bay)
°C	Degrees Celsius
DD	Degree days (based on degrees Celsius)
GJ	Gigajoules
GWh	Gigawatt hours
km	Kilometers
km^2	Square kilometers
km/h	Kilometers per hour

KRG	Kativik Regional Government
kWh	Kilowatt hours
l	Litres
$l/m^2/DD$	Litres per square meter per degree day
m	Meters
m^2	Square meters
m^3/sec	Cubic meters per second
mm	Millimeters
MW	Megawatt
MWh	Megawatt hours
n	Sample size
N	North
p.a.	Per annum
s	Standard deviation
SI	Systeme International
W	Watt
W	West
$\bar{x}$	Mean
$\$/m^2/DD$	Dollars per square meter per degree day

KATIVIK EFFICIENT ENERGY STUDY

An energy study and training program in Kuujjuaq and Kangirsuk, Quebec

Executive Summary

Kativik Regional Government and Makivik Corporation in northern Quebec decided in 1983 to undertake an energy planning study and training program for northern Quebec. Referred to locally as the Kativik Efficient Energy Program (KEEP), the study took place over 10 months in 1984 and 1985, with financial contributions from the Remote Community Demonstration Program of Energy, Mines and Resources Canada; Hydro-Québec; La Société d'Habitation du Québec; Kativik Regional Government, which managed the study; and Makivik Corporation.

Fourteen Inuit communities in northern Quebec, with populations ranging from 100 to 1,200, come under Kativik Regional Government. These 14 communities are also of concern to Makivik Corporation, an Inuit corporation set up to ensure that the James Bay agreement of 1975 is respected.

This Kativik study concentrated on two communities: Kuujjuaq, formerly known as Fort Chimo, (pop. about 1,200) was chosen as an example of a large centre; and Kangirsuk, formerly known as Payne Bay, (pop. about 300) represented an average-sized village. Both are located on Ungava Bay.

The largest energy consuming group in the communities is the residential energy sector, so the housing stock became the focus of the study.

The first task was to compile a data base on residential consumption of electricity and heating fuel. Limitations to the information presented and techniques used to estimate missing data are described. Household electricity and heating oil consumption patterns are graphically depicted for unrenovated, renovated and new buildings.

Domestic heating oil consumption and costs have decreased slightly over the past three years in Kangirsuk, and have increased by 9% a year in Kuujjuaq.

Domestic electricity consumption and costs have increased significantly in both communities. In Kangirsuk, household electricity consumption has gone up an average of 35% per year since 1982, and total costs have risen 58% per year. This is because of an increase in the number of houses. In Kuujjuaq, consumption has risen 10% per year, and costs, 22%.

The second task involved training. In fall 1984, five Inuit in the two communities participated in a four-month "on-the-job" training course which taught them to find energy losses in houses and how to remedy the situation. They learned about no-cost and low-cost energy conservation measures such as weatherstripping, caulking and glazing improvement. Consultants from the "south" (Montreal) supervised the training.

A total of 23 houses were retrofitted at an approximate cost, including manpower, of $675 per house. Monitoring of all the KEEP retrofitted houses in Kangirsuk for three months indicates the payback period is expected to be less than a year.

The report also discusses mini-hydro, tidal, wind and solar potential for both communities. The last three are considered possibilities, but would need much more investigation.

The study succeeded in its primary goal of developing people's awareness of energy and the need to conserve it. The "house doctors" played an important role in this respect. The study also demonstrated the ability of the local people to acquire the skills to improve their own housing conditions.

It should be noted that, even before the study was completed, it succeeded in interesting other people in the work. A third Kativik community, Tasiujaq (formerly known as Leaf Bay or Baie-aux-Feuilles), hired the consultant for a few days to explain the KEEP project and demonstrate some energy conservation techniques. During this time, two houses in Tasiujaq were weatherstripped and caulked.

The consultants hired to undertake the study were Memphremagog Community Technology Group and Chalifour, Marcotte et Associés Inc.

ÉTUDE KATIVIK D'EFFICACITÉ ÉNERGÉTIQUE

ÉTUDE SUR LA PLANIFICATION ÉNERGÉTIQUE ET PROGRAMME DE FORMATION

À KUUJJUAQ ET À KANGIRSUK (QUÉBEC)

Résumé

En 1983, le gouvernement régional de Kativik et la société Makivik ont organisé conjointment une étude portant sur la planification énergétique et un programme de formation pour le Nord québécois. L'étude connue localement sous le nom de KEEP* s'est étalée sur 10 mois entre 1984 et 1985 et a bénéficiée de subventions d'Énergie, Mines et Ressources Canada dans le cadre du Programme de démonstration dans les collectivités éloignées ainsi que de subventions de la Société d'Habitation du Québec, d'Hydro-Québec, du gouvernement régional de Kativik, qui a dirigé cette étude, et de la société Makivik.

Le gouvernement régional de Kativik administre 14 collectivités inuits du Nord québécois dont la population varie de 100 à 1 200 habitants. Ces 14 collectivités sont aussi administrées par la société Makivik, une corporation inuit mise sur pied pour assurer le respect de la Convention de la Baie James de 1975.

Cette étude du gouvernement régional de Kativik porte principalement sur deux collectivités. Il s'agit de Kuujjuaq, connue auparavant sous le nom de Fort Chimo (1 200 habitants environ), et qui a été choisie parce qu'elle représente un grand centre typique du Nord québécois; et de Kangirsuk, appelée autrefois Payne Bay (200 habitants environ), représentant un village de dimensions moyennes. Ces deux collectivités sont situées dans la Baie d'Ungava.

La première étape a consisté en la compilation de base de données portant sur la consommation résidentielle d'électricité et de combustible de chauffage. On a décrit les difficultés rencontrées dans la cueillette d'information et les techniques utilisées pour estimer les données indisponibles. La consommation d'électricité et de mazout est exprimée à l'aide de graphiques pour les bâtiments non renovés, rénovés ou neufs.

* Kativik Efficient Energy Program (Programme Kativik d'efficacité énergétique).

Depuis trois ans, la consommation domestique et les coûts du mazout ont légèrement baissé à Kangirsuk, alors qu'ils ont augmenté de 9% par an à Kuujjuaq.

La consommation domestique et les coûts de l'électricité ont sensiblement augmenté dans les deux collectivités. À Kangirsuk, la consommation domestique d'électricité s'est accrue en moyenne de 35 % par année depuis 1982 et le coût total a atteint 58 % par année. Ceci s'explique par l'augmentation du nombre de maisons. À Kuujjuaq, la consommation a augmenté de 10 % par année, et les coûts de 22 %.

La seconde étape de l'étude portait sur la formation. À l'autonme 1984, cinq Inuits provenant de ces deux collectivités ont participé à un stage de quatre mois en milieu de travail pour apprendre à identifier les pertes d'énergie dans les maisons et comment y remédier. Ils ont appris des méthodes d'économies d'énergies qui ne suscitent aucun déboursés ou qui sont très minimes comme l'ajout de coupe-froid, l'amélioration du calfeutrage ou du vitrage. La supervision de la formation a été assurée par des experts-conseils de Montréal.

Des rénovations ont été effectuées sur 23 maisons pour un total approximatif, en tenant compte de la main-d'oeuvre, de 675 $ par maison. Un suivi de toutes les rénovations effectuées pendant trois mois sur les maisons de Kangirsuk indique que la période de recouvrement pourrait être inférieure à un an.

Le rapport fait aussi mention d'autres énergies de rechange applicables aux deux collectivités comme l'hydro-électricité, l'énergie marémotrice, éolienne ou solaire. L'utilisation des énergies marémotrice, éolienne ou solaire offrent des possibilités mais nécessitent des études plus approfondies.

L'étude a atteint son objectif premier pour ce qui est de la sensibilisation des gens à la necessité d'économiser de l'énergie. À cet égard, les bricoleurs ont joué un rôle important. L'étude a aussi démontré l'aptitude des gens à acquérir des techniques pour l'amélioration de leurs maisons.

Il est à noter qu'avant même la fin de l'étude, d'autres personnes s'étaient montrées intéressées par le projet. Tasiujaq, une autre collectivité de Kativik (connue auparavant sous le nom de Leaf Bay ou de Baie-aux-Feuilles), a engagé l'expert-conseil pour quelques jours afin qu'il leur explique le projet Kativik et leur fasse une démonstration de quelques techniques d'économies d'énergies. Pendant ce temps, deux maisons de Tasiujaq furent calfeutrées et munis de coupe-froid.

Le gouvernement régional de Kativik a retenu les services des firmes Memphremagog Community Technology Group et Chalifour, Marcotte et Associés Inc. pour effectuer cette étude.

1.0 INTRODUCTION

1.1 Background on the Project

The Kativik Efficient Energy Program (KEEP) originates from a proposition presented by the Kativik Regional Government (KRG) to Energy, Mines and Resources Canada (EMR) in 1982. The project started in April 1984 and took place under the Remote Community Demonstration Program (RCDP) Phase I. Besides EMR, the main funding agency, four groups collaborated in KEEP: Hydro Quebec (HQ), La Société d'habitation du Québec (SHQ), Makivik Corporation and the Kativik Regional Government (KRG) (1) (see Table 1-1). Delegates from each group formed the project's steering committee but its management and coordination was assumed by KRG (see Table 1-2).

TABLE 1-1 KEEP FUNDING BREAKDOWN

EMR	115 000
SHQ	25 000
HQ	25 000
MAKIVIK	5 000
KRG	5 000

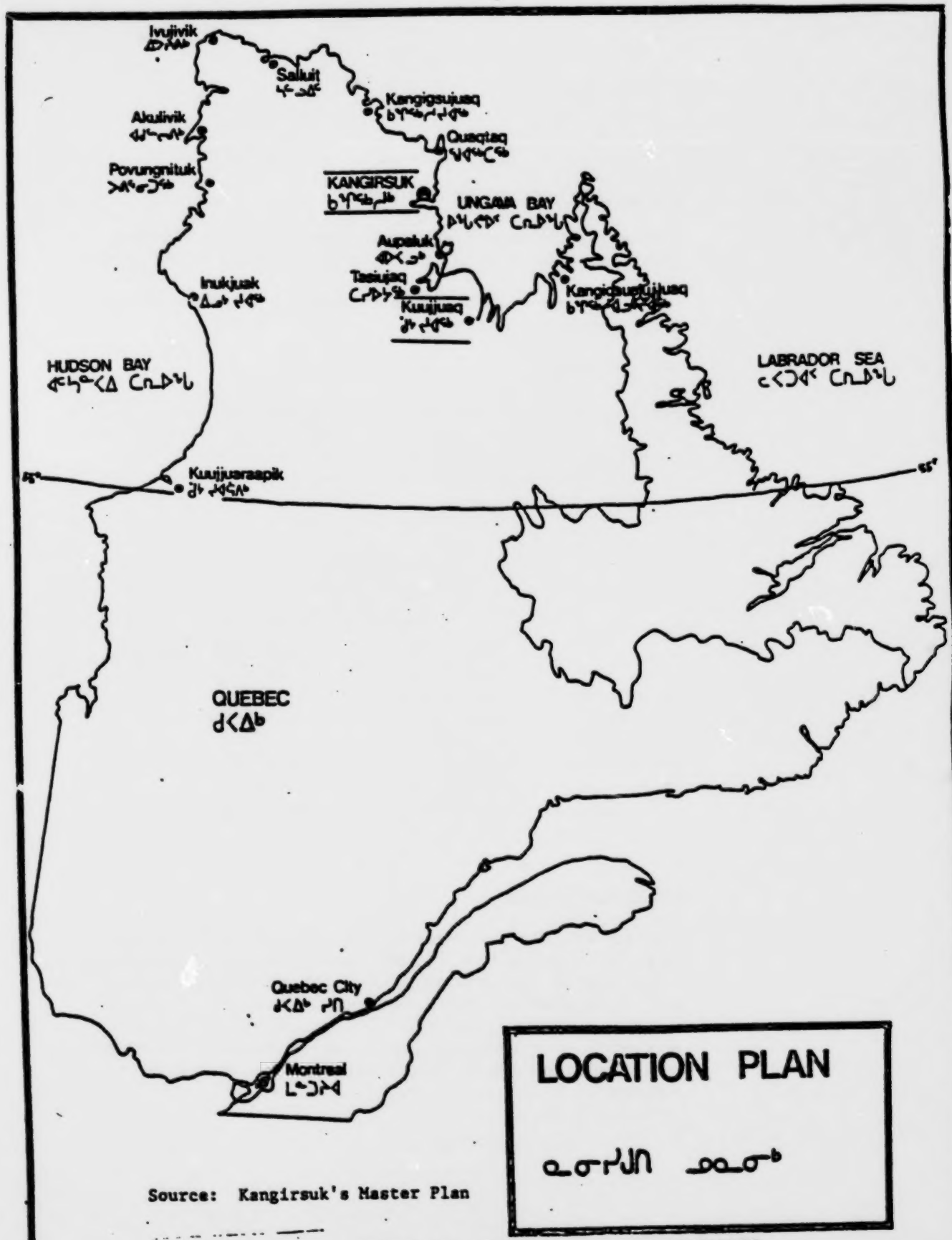
(1) See Glossary

TABLE 1-2 MEMBERS OF KEEP'S STEERING COMMITTEE

NAME	ORGANIZATION	POSITION
Michael Barrett	KRG	Head of Environment Section
Paul Bélanger	MAKIVIK	Assistant to the President
Hervé Chatagnier	KRG	Secretary, KEAC, KEQC
Alain Déry	SHQ	Research agent
Lucien Jean	HQ	Manager, HQ
Richard Lalonde	EMR	Director, CREO
Michel Lamanque	EMR	Head of RCDP
Noel Mainguy	SHQ	Technical standards agent
Willie Makiuk	KRG	Manager, KRG
Louise Millette	KRG	Project Coordinator

The main goal of the RCDP projects is to encourage communities that are not connected to the main hydro-electric power networks to reduce their dependency on oil. To achieve this goal, two types of activities took place under KEEP.

First, from April 1984 to August 1984, an energy data base was gathered (see Chapter 2-0). A technical training program then took place from August 1984 to December 1984 (see Chapter 3-0). The rest of the time and budget was used to sketch an energy plan for the communities (see Chapter 4-0) and organize the reports. It was decided that these activities would take place in two of the communities under the jurisdiction of KRG. Both of them were selected on the Ungava Bay coast to reduce travelling time. Kuujjuaq (pop. 916) was chosen as an example of a large center and Kangirsuk (pop. 256), an average size village (see Figure 1-A).



Source: Kangirsuk's Master Plan

FIGURE 1-A LOCATION PLAN OF COMMUNITIES

1.2 Purpose of the Report and Objectives

The purpose of this report is to summarize the work done within the scope of RCDP's Energy Planning and Training for Northern Quebec and assess its validity.

Hopefully, this report will be useful to anyone dealing with energy matters in Quebec, north of the 55th parallel.

1.3 Information Sources

With the exception of the data presented in the Data Base Report (Appendix B), the information presented in this report was obtained from first hand observation by members of the KEEP personnel (See Table 1-3). Most of it is from direct measures, the rest was extracted from the municipal files or gathered through interviews with the population.

TABLE 1-3 KEEP'S PERSONNEL

NAME	POSITION
David Cooper	Trainee in Kuujjuaq (Sept 17-Dec 14)
Mathew Gordon	Trainee in Kuujjuaq (Sept 17-Nov 16)
Jimmy Kauki	Assistant to the Coordinator in Kangirsuk (June 18- Dec 5)
Louise Millette	Project Coordinator
Jeannie Nungak	Trainee in Kangirsuk (Sept 24-Dec 10)
Edward Putulik	Trainee in Kangirsuk (Sept 24-Dec 10)

1.4 Limitations of the Report

The reader will find a minimum of "hard data" in this analysis. Two reasons govern this orientation. First, the energy figures required for in-depth analysis need to be monitored for fairly long periods (e.g. several months) before being useful for significant comparisons. Since only a few weeks were left after the completion of the training, the monitoring still goes on. Secondly, the type of work performed during the training, e.g. training and information, does not lend itself to collection of extended figures but to a more global, less concrete evaluation.

1.5 Scope of Coverage

As mentioned in section 1.1, two groups of activities, in addition to the data analysis, took place during KEEP. Their description makes up the main body of this report, followed by the global conclusions and recommendations.

1.5.1 Data Base Report

A preliminary form of this report was presented to the Steering Committee on August 7, 1984.

As planned, the report was reviewed and modified with the comments of the committee and the revised version is included in Appendix B. Chapter 2.0 presents a short overview of the contents of the data base report.

1.5.2 Training Program

The end of the training activities should have been marked by the project's coordinator presentating an activity report. However, for various reasons, one of which was the surprisingly long period of on-the-job assistance required for the well-being of the training, the activity report is now included as Chapter 3.0.

1.5.3 Energy Plan

After the data base organization and with the experience of the training, some of the communities'energy trends, which compose their energy plans, were outlined. They are presented in Chapter 4.0.

2.0 REVIEW OF DATA BASE REPORT

2.1 Objectives and Scope

An information or data base has been developed as an integral part of this project in order to provide a context into which the rest of the project can be placed. The prime objective of prepering a data base report was to present one document which gives as complete a picture as possible of energy use and resource availability in the communities of Kangirsuk and Kuujjuaq. This data base was intended to be used in the subsequent energy training and planning phases of the project.

The report covers historical, present and future energy supply and consumption in the two communities. Information is presented in the form of tables, charts and graphs on electricity and fuel supply and consumption, household energy consumption patterns, motor vehicle consumption statistics and costs of energy. Information is presented on relevant energy conservation and renewable energy technologies and resources, their impacts and feasibility. Demographic data on each community has been included to provide a reference for trends and predictions.

2.2 Limitations

Due to time and money constraints, the report focuses mainly on the residential energy sector. It only briefly touches upon transportation and does not deal at all with industrial or commercial energy sectors. It does, on the other hand, include some energy use data for non-residential buildings in each community. The reasons for treating the study in this way were that it became very quickly apparent that the residential sector is by far the most important energy consumer in the two communities and that the data is more accessible from residential suppliers and consumers than comparable data from the other sectors. On the other hand, the researchers found virtually no dissagregated access to fuel consumption records for non-SHQ or non-council buildings. Neither individual households nor fuel suppliers were able to provide records of fuel consumption for personal transport.

2.3 Methodology

2.3.1 Gathering Techniques

- o Literature search:
  - computerized (5 data bases accessed - 308 titles)
  - government publications
  - library searches
- o On-site data acquisition:
  - household surveys
  - council records
  - HQ and Shell records (internal documents)
- o Historical consumption figures form files:
  - HQ
  - SHQ
  - Shell
- o Survey of on-going studies:
  - University of Montreal
  - EMR
- o Personal communications:
  - other researchers
  - experts

2.3.2 Data Presentation

The information in the Data Base Report has been presented in four major sections. The first two give information on each community relating to community demographics, energy supplies, energy consumption and the hydro-electric potential in surrounding watersheds. The data is presented in the form of tables, charts and graphs with some narrative comments or analysis.

Demographic data, specifically that relating to population and buildings, were taken primarily from the master plans for the Northern village corporation of Kangirsuk and Kuujjuaq. All the other graphs and tables in the body of the report were developed by the authors of the report using data obtained from supply and consumption records.

The third section of the report comprises information that is relevant to both communities. It includes fossil fuel prices in Northern Quebec, comparative household energy consumption figures in Southern Canada, insulation levels in SHQ housing and assessment of renewable energy resources in the North, such as tidal, wind, solar and biomass power. In addition, the impacts of various energy resources and technologies are briefly discussed.

The final section summarizes findings, interprets some of the data and suggests some recommendations for future data gathering in and for the communities.

The appendices include 24 pages of climatic data on Kangirsuk and Kuujjuaq and an annotated bibliography containing 67 entries on energy and housing in the North.

2.4 Available Data

2.4.1 Energy Supply

The major energy supplies for the communities are various grades of fossil fuels. Kangirsuk receives Shell Northern Distillate as furnace oil and Regular Leaded Gasoline for transportation needs. Kuujjuaq uses Shell Jet A-1 as furnace oil and Regular Leaded Gasoline for transportation needs. In addition, Shell Aviation Gasoline 100 is periodically delivered to Kuujjuaq as airplane fuel.

Energy supply information for both Kangirsuk and Kuujjuaq comprises the actual volume of sales of furnace oil and gasoline for the years 1980 through 1984 and kWh of electricity produced for the 18-month period ending in May 1984. Heating fuel and gasoline volumes are given as annual totals and projected sales are made to 1990 based on Shell Canada's best estimate for future sales of 5% annual increase. Electricity production is given in monthly kWh produced, with monthly oil consumption to produce the electricity presented on the same graphs. No electricity supply projections have been made. However, it is anticipated that electricity production will keep pace with consumption, which increased an average 16% per year from 1982 to 1984 in Kangirsuk, and an average 12% per year over the same period in Kuujjuaq.

2.4.2 Energy Consumption

Energy consumption data is presented in parallel for Kangirsuk and Kuujjuaq. Furnace oil consumption is presented per SHQ housing unit in tabular form, for the years 1982-1984 for Kangirsuk and 1981-1984 for Kuujjuaq. Both volume and cost data are presented. This data is then used to construct graphs of total volume consumed in each community per year, and the costs to the community. High growth and low growth consumption scenarios are projected, along with Shell Canada's estimated rates of increase, in both consumption and price. Similar information is presented for electricity consumption and costs for SHQ housing in both communities.

For Kangirsuk, three SHQ housing units were chosen for a graphical plotting of their oil and electricity consumption on a bi-monthly basis over an 18-month period. The houses were randomly selected to represent three categories of housing: early construction unrenovated, early construction renovated during data period and recent construction.

For Kuujjuaq, it was possible to separate those houses with oil and electric cook stoves. The data has been presented in tabular form, and the average oil and electricity of these houses compared with the other houses not having that type of cook stove. The data for houses with oil cook stoves shows an insignificant difference in fuel consumption compared to houses without oil cook stoves. On the other hand, houses with electric cook stoves showed a much higher average electricity consumption than those without. However, this could be a consequence of the increased number of electrical appliances in renovated houses that all have electric stoves.

Fuel consumption in municipal vehicles in Kuujjuaq is presented in tables for the years through 1983.

2.4.3 Renewable Energy and Conservation Technologies

Information on the use of renewable energies and technologies relating to energy conservation in Northern Quebec is virtually non-existant. No renewable energy resource has received in-depth study; most have been virtually neglected.

Hydro-Quebec has identified three hydro-electric sites near Kangirsuk and three near Kuujjuaq as potentially capable of supplying a significant portion of the electricity demand for each of the communities. The best site near each community is briefly described in the Data Base Report. The description includes the projected electrical energy demand for the year 1990 and the estimated output of the proposed site. Estimated development costs are also given.

Tidal power has received some attention. Some nine sites on the Ungava Bay have been identified as potentially suitable for tidal power installations. Their estimated total capacity would be 26 400 MW. However, development of these sites is not considered feasible in the near future considering the current knowledge of ice and water conditions in Northern seas as they relate to tidal power installations, and given current non-competitive costs for such installations elsewhere in the world.

Wind energy data from the coastal zones of Ungava Bay indicate promising potential for the production of electrical energy adequate to meet the total demand in each of the communities. However, no in-depth analysis of the potential for utilizing wind power has been made, to date.

The potential for using solar energy in both Kangirsuk and Kuujjuaq is significant, especially in the period from March through October, to offset oil, or electric, space or water heating. However, again, no study has been undertaken on this energy resource.

Biomass productivity is very low in the region of the two communities. It is essentially unexploitable using today's technologies of energy conversion.

On the other hand, some relevant conservation and renewable energy information is available in studies and texts written about and for similar communities elsewhere in Northern Canada. Much of this information has been reviewed by the authors and is included as an Annotated Bibliography in the Appendicies to the Data Base Report.

2.5 Missing Data

2.5.1 Energy Supply

Energy supply data for all major end-uses is available for both communities from 1980 through 1984. There are some minor energy supplies, for example propane and other bottled gas, for which, however, no records are available. It is known that two SHQ houses and six KRG houses in Kuujjuaq currently use propane gas for cooking. Each house uses approximately two 100-pound cylinders per year. It is anticipated that these stoves will be replaced by electric ones in 1985.

Camping gas supplies, in the form of small pressurized cylinders, are sold at the Bay and the Coop in both communities. Again, records of the quantities are unavailable.

All of these bottled gas sources represent a minute part of the total fuel used. Thus, even though the data is missing, its non-inclusion in the energy supply data has little significance.

2.5.2 Energy Consumption

Energy consumption data for household and community wide transportation use was not available. No records of this have been kept by any consumer, except the councils in both communities and even these records are incomplete.

There was no easy access found to heating fuel consumption records for buildings that belonged to individuals or groups other than SHQ, the councils or KRG. In some cases the data was unavailable, in others it would have involved visits to each of the houses or buildings concerned, contacting their head offices and other efforts which the project did not have the resources to undertake.

The domestic fuel consumption records that were accessed were often incomplete, with inaccuracies due to previous building re-numbering, single delivery recording for two adjacent houses or no recording of a delivery.

Nordair did not respond to requests for air transport fuel data. Air Inuit did respond by opening their files to the authors. However, the time to extract the relevant information would have been too great when assessed against the relative importance of the data for the overall project aims.

All consumption data are also missing for the relatively minor commercial and industrial sectors for reasons outlined in Section 2.2.

2.5.3 Renewable Energy and Conservation Technologies

Data on renewable energy and conservation technologies relevant to Northern Quebec is available in the report. However, too little of this information results from studies or work done in or for Northern Quebec.

2.6 Recommendations

The Data Base Report is a first effort at accumulating and recording energy related information for Kangirsuk and Kuujjuaq. It is strongly recommended that this report be upgraded as new information becomes available. To develop a more comprehensive and inclusive data base requires continuing effort on the part of those involved in energy related concerns in each community. Specifically, the following recommendations are made:

1. The councils should upgrade their techniques of recording oil and electricity consumption for each household or building. The office computers available in each community can be of great assistance in this.

2. Records of the total annual household and building oil and electricity consumption should be maintained.

3. Random households in each community can be selected to maintain records over a twelve-month period for all transportation fuel purchases for the household.

4. HQ and Shell supply and consumption records should be retrieved dating back to 1970 for each community. If other suppliers of electrical power and fossil fuels existed at any time during this period, their records should be accessed.

5. The results of any on-going energy and housing related studies should be incorporated as they become available.

6. A small weather station should be established in Kangirsuk to record solar radiation, wind-speed and direction (at two locations, the village and the airstrip), and temperature.

7. Data bases for each of the other Inuit communities in Northern Quebec should be developed to determine similarities, differences and anomalies.

3.0 TRAINING PROGRAM ACTIVITY REPORT

3.1 Background on the Training

The sixteen-week training portion of KEEP was, from the very beginning, one of its vital components. It was intended to achieve two distinctive goals: general information and transfer of technical skills. There was also a broader, longer-term objective to the training. From the new energy consciousness, it was hoped that a desire for energy independence would arise and that the general public would see energy conservation as the first step toward self-sufficiency.

The training started in August 1984 and ended in mid-December 1984. In two communities, five Inuit received the training and retrofitted a total of 19 private households and four community buildings. The trainees learned new skills "on-the-job". Theoretical questions were answered as they arose in the learning process; there were/no classroom lectures.

3.2 Statement of Purpose of the Chapter

The purpose of this chapter is to provide an activity report of the KEEP training sessions, including an analysis of the impacts observed.

3.3 Limitations to the Chapter

The activities that took place during the training are described entirely but briefly. Since nothing new and innovative was taught, there is no need for technical details. Moreover, the reader will find an in-depth description of the carpentry and energy conservation techniques that were taught in the training manual (See appendix E).

Also, as explained in section 1.4, a serious analysis will require many months of monitoring before leading to significant results. Therefore, few calculations will be found in this chapter as the evaluation stays within realistic limits.

3.4 Description of Activities

This section is more or less chronologically organized although some overlapping is inevitable. A bar diagram of the training activities is presented in Figure 3-B, at the end of this section, page 21.

3.4.1 Selection of Personnel

One of the key participants in the project was the full-time Inuit coordinator's assistant in Kangirsuk, where KRG has no office. A local person, with a good knowledge of the English language and a sense of initiative, was looked for. The normal procedure of posting the job description in the community was followed but the summer activities (it was in June) made it difficult to contact the population; most of the families being in fishing camps outside of the community. Finally, a candidate recommended by the town council was hired. All through the project, it was proven that the local representant was a vital element to the project, mostly for community outreach.

Similar qualifications were asked of potential trainees, carpentry or general construction experience being an additional asset. After a few interviews, three men and one woman were hired in August, in spite of the delays resulting from the summer traditional hunting and fishing activities.

3.4.2 Choice of Consultants

Three energy consultant firms were invited to submit proposals for the technical training part of the project. In the job description, the emphasis was put on the need for the energy experts to demonstrate excellent skills in teaching technological skills in potentially delicate situations. Time for on-the-job training, i.e. presence north of the 55th parallel, was also outlined as a prerequisite to the job, along with an excellent knowledge of the English language.

After serious consideration of all the propositions, it was concluded that the most would be made of the project if two groups of energy experts with different backgrounds were asked to cooperate on the project.

One community-oriented firm, with remote community experience, was hired to supply, along with the knowledge of energy conservation technologies, its experience in technology transfer. This was the Memphremagog Community Technology Group. The other firm, CMA Chelifour, Marcotte et Associés Inc., was to bring to the project a vast experience in training and manual preparation, both in energy conservation skills and furnace maintenance and repair techniques.

3.4.3 Choice of Materials

Since none of them were available in the communities, the materials and most of the tools required for the project were purchased in the Montreal region and by air cargo. To stay within the project's budget, only infiltration reduction related material were purchased, as described in Table 3-1.

The project took advantage of CMA's ten-year experience in energy conservation and of the knowledge they had acquired in performing material evaluation for Hydro-Quebec's programs Energain I, II and III. In the selection, attention was given to good, long lasting products that would be relatively easy to find after the end of the project if the municipalities wanted to keep some in stock for building improvement.

Basic toolboxes (screwdrivers, staplers, pliers, hammers, cutters, measuring tape, etc.) were also supplied to make sure that the house-doctor training would not be slowed down by the lack of proper tools. Two 18-inch fans were also purchased for the performance of pressure-infiltration tests.

TABLE 3-1 CHARACTERISTICS OF MATERIAL USED FOR KEEP*

Description	Brand Name	Suppliers	Reason for Selection
Spring weather-stripping	Climaloc	Ravary	o Flexible to adapt to doors in poor condition o Easy to ship (lightweight and short lengths) o Adjustable o Long lifetime (3-5 years) o Good down to -30° C
Doorsill weatherstripping	Climaloc	Ravary	o Good rubber seal o Aluminuim = longer life in difficult conditions
"V" type weatherstripping	3M	Ravary	o Very good glue o Proven good in lab o Flexible, thougher material
Caulking	Synkone (silicone)	Bulldog Grip	o Clear and paintable o Easy to apply & remove o Minimal odor o Good life (flexible)
Polyurethane foam	Sista	Sista	o New brand, proven good o Easy to apply and more than one use container
Plastic frame for storm windows	Fing-R-lock	Ravary	o Very resistant o Good price
Clear plastic	Poly fastener	Ravary	o 6 mm thickness (more resistant) o Resists to UV o Very clear
Two-sided tape	Climaloc	Ravary	o Good glue o insulating
Electrical outlet pads	Climaloc	Ravary	o available

* Some wood and miscellaneous material was supplied by the municipal councils of Kuujjuaq and Kangirsuk, mostly from the equipment left by SHQ.

Source: Guy Dubois, CMA

3.4.4 Choice of Training Sites

It appeared obvious that the best training sites for the project would be Inuit houses. At the same time as it was accomplishing a useful maintenance job, KEEP would be contacting the population. By increasing the comfort of the houses, the project and, hopefully the general energy conservation concept, would get some word of mouth publicity.

To select the houses, KEEP asked the communities' housing managers to point out the houses they thought would need energy conservation measures and would not be renovated in the near future. A total of 19 private houses were worked on, out of approximately 25 recommended houses. (See table 3.2). It turned out to be a good enough selection process, although in Kuujjuaq, priority had to be given to houses where the tenants were responsive and cooperative. By working on these sites, KEEP was also hoping to get some feedback from the population on the whole concept.

Later in the project, the councils expressed interest in having the team work on community owned buildings, where cash savings were direct. Four such buildings were worked on.

Table 3-2 Buildings winterized by KEEP

Community	Type
Kangirsuk	o Private houses (109,113,120, 122, 128, 132, 141) o Community Hall o Old Church Hall o KEEP house
Kuujjuaq	o Private Houses (76,90, 106, 110, 123, 124, 125, 133, 184, 191, 199) o Katimavik House o Day care centre

3.4.5 Content of Training

For budget and feasibility reasons, the technical training was limited to infiltration reduction techniques that will be called "winterization" for the remaining of this report.

The first skill the trainees needed to acquire was the ability to recognize air leakage problems in a house. To help them visualize the leaks, a fan was used to pressurize the house and cold smoke was introduced to track down the air paths. The same smoke test would later be useful for the trainees to evaluate the efficiency of their work.

After the problem zones were identified, the trainees learned what was believed to constitute the most needed winterization measures: weatherstripping adjustment to doors and windows; caulking around windows, doors, pipes and construction seams; installation of plastic storm windows. However, it rapidly turned out that a lot of preliminary steps would be needed before these measures could be applied to the chosen houses.

For example, the first house visited in Kangirsuk was found to have eight broken or missing window panes. These panes had to be replaced before conservation measures would make any sense, so the trainees learned how to do it. As time passed, the needed carpentry skills increased and the team learned to adjust doors and windows, change quarter-rounds and window frames. Cooperation was established with the maintenance persons of the municipalities where they would cut the windows and bring over any required wood.

Along with these difficulties resulting from the poor condition of the houses, KEEP also encountered other operational problems. It was, for example, common for the team to have to wake up the house tenants before starting the morning work. This caused some minor but repeated delays. Also, because the old houses often shelter two or three persons per room, it was often quite a task to get to where the leaks were. The furniture moving and area cleaning used up a significant part of the work day.

In order to keep track of the work performed in each house, the trainees were provided with house-report forms to fill out for each house. In Kangirsuk, because six of the seven houses worked on were of the same type (three-bedroom Indian Affairs house model 455-30), only one example of house-report is presented. (Appendix c). The activities were roughly the same for each house:

- Replacing 6 to 8 window panes
- Weatherstripping and sealing 8 windows
- Installing storm windows on 6 of them
- Adjusting, weatherstripping and sealing two doors
- Sealing all floor-wall joints
- Sealing miscellaneous leaks around pipes, drains, etc.

The crew took about five days to perform these tasks and used up approximately:

- 1 1/2 dz tubes of caulking
- 1 box "V" type weatherstripping
- 8 m of door weatherstripping (1 1/3 pack)
- 1 can polyurethane foam
- 1/3 box clear storm window plastic
- 1/3 box storm window frame
- Quantities of cleaning products and paper towels

In Kuujjuaq, the situation was different. The trainees were confronted with many different types of houses ranging from one-bedroom matchboxes to five-bedroom houses. Also, after the analysis of the house-reports, it became obvious that not all questions had been well understood and that a clearer questtionnaire would be required for future work. Nevertheless, the data gathered from those reports is summarized in Table C-1 (appendix c) and shows that an average house required:

- Adjusting and weatherstripping 2 doors
- Fixing and caulking 5 windows
- Installing 5 storm-windows on windows
- Installing 4 storm-windows on air-vents
- Sealing miscellaneous holes and cracks.

The house-reports do not contain the information to estimate all the material required for performing these tasks but allow to estimate that the following quantities were used:

- 4 to 5 tubes of caulking
- 1/4 box of "V" type weatherstripping
- 2 packages of door weatherstripping

3.4.6 Community Outreach

Because the training took place in private homes, KEEP was noticed by the population. However, some more community-oriented activities were included in the training period. Among them, the following can be listed:

1. Posters showing energy conservation technologies and products displayed in local stores

2. Open house at Kangirsuk's KEEP House where a pressure test was performed and some techniques demonstrated

3. Poster contest among primary school students of both communities

4. Two local FM radio announcements

5. Two articles in Taqralik magazine

6. Buttons, caps and T-shirts printed with the KEEP logo (See Figure 3-A)

Figure 3-A KEEP LOGO

Source: Northwest Territories Government

7. Energy conservation information material made available by EMR at the KEEP House

8. Council meetings in both communities

9. Energy conservation activities kit given to teachers in both communities' elementary shcools

10. Participation in KEEP of Kuujjuaq's Katimavik group

11. Production of KEEP's video, "Save a little ... Gain a lot"

12. Community volunteer work on Kangirsuk's recreation hall

13. Poster session at the Kativik Environment Conference, December 10-12, 1984, in Kuujjuaq

BAR DIAGRAM (44 WEEKS)

ACTIVITIES	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCT.	NOV.	DEC.	JAN.
Selection of consultants	———	———								
Selection of assistant	———	———								
Selection of trainees			———	———	———					
Data Base gathering	———	———	———	———	———					
Site visits	—	—		—	—					
Draft Report Training program					———	———	———	———		
Video production							———	———		
Kativik conference									—	
Report writing										———
Committee meeting		(May 3rd)			(Aug. 7th)		(Oct. 15-17)		(De.14)	(Ja.28).

FIGURE 3-B BAR DIAGRAM OF KEEP'S ACTIVITIES

3.5 Result Analysis

3.5.1 Audience Response

The main goal of KEEP being the transfer of information to the population, the analysis of the project's impact has to go through the assessment of the people's reaction to it. Since such an evaluation is virtually impossible to quantify, the following analysis cannot help being subject to the authors' perceptions. More importance is attached to the qualitative evaluation of the work than to the quantification of the savings.

3.5.1.1 Trainees (and Assistant). In spite of the extra skills required by KEEP's team, as detailed in Section 3.4.4, the training program was completely successful.

After seeing the trainees at work alone, it appears that they are able to find the energy leaks and take the required measures to suppress them. The pressure smoke infiltration test also provided them with a positive auto-evaluation means.

At the end of the training program, the motivation of the groups appeared to go down. It is difficult, at this point, to determine whether this was caused by a decreasing interest in the work, the approaching end of the program without assurance of continuation or the approaching Christmas holidays. Regardless, it is certain that some trainees would be more interested in a permanent job than in a short term contract.

It was also noticed that the trainees functioned best in team of at least two people, one of them preferably being a woman. This may be explained by the traditional responsibility of house maintenance by women and their interest in improving home comfort.

3.5.1.2 General Population. The start-up of the community outreach portion of KEEP, in other words, its recognition by the general public, was a slow process. In addition to the overall skepticism expressed toward another short-term project, KEEP had to deal with the language difficulties. Because there is no word in Inuktitut to express the general concept of energy or energy conservation, it took some time before the community members understood what the project was all about.

When it became clear that the group was working on infiltration reduction, the public response was good. The comfort issue proved to be a valuable one and the council members also raised the cost savings aspect of KEEP for community buildings. However, if the tenants of the winterized houses expressed their satisfaction towards the comfort improvement, they showed little interest in learning the retrofitting skills themselves. Besides a few exceptions, they left the work to be entirely performed by the group.

The response to the various community outreach measures undertaken changed with the type of measure.

1. Posters and displays. Posted information was a good communication mean. The best results were obtained when samples of the demonstrated products were attached to the sign with explanations in Inuktitut and English. It raised questions about the availability of such products.

2. Open house. The open house in Kangirsuk had a successfull impact. It might have been interesting to repeat the experience but such an activity demands quite a bit of preparation and several people to manage it successfully.

3. Poster contest. The participation of the students to the poster contest depended a lot on the teachers involvement. The participation in Kangirsuk was better than the one in Kuujjuaq but, overall, it was quite satisfactory. In addition to launching the project, it allowed to measure how little both the students and teachers understood of the energy conservation concept.

4. FM radio. Virtually everyone listen to the local FM radio. The announcements made are usually successful, especially if there is time for people to phone in their comments. A series of talks would have helped to clarify KEEP's function.

5. Taqralik. Again, almost everyone up north reads Taqralik. The single paper published at the beginning of the program was responsible for a lot of the wider recognition. CBC North phoned in to ask some additional questions and the community of Tasiujaq hired Guy Dubois from CMA to help them initiate a mini-KEEP. A second article was published in the January 1985 issue.

6. Logo. The material printed to KEEP's logo had a mitigated success. Part of it can be attributed to the fact that, in spite of the assistant's assurances, a lot of people had some trouble to understand the North West Territories Inuktitut borrowed for the logo. A local contest, given sufficient time, would have been a more viable option.

Windigo

7. Written material. Although written information was available to all the population, almost no one took advantage of it. This fact should be remembered when the moment of a wider technology transfer operation comes.

8. Council meetings. Meetings with the communities' council members was definitely a requirement. The best input came when the project was already on its way and the activities well understood.

9. School kits. The teachers responded favorably to a new set of activities involving energy conservation. However, no feedback has come yet, as it takes some time for them to find the moment to initiate the classes activities.

10. Katimavik. The role of a Katimavik group should be to perform community oriented tasks. By sponsoring the Kuujjuaq group, KEEP hoped to winterize more houses and, therefore, touch more people. The caribou catastrophy, the billeting period and various operation problems, greatly reduced this contribution.

11. Video. Although the video has, up to now, received a favorable response, it is still too early to say to what extent it will transfer energy conservation consciousness.

12. Volunteer work. Kangirsuk's population participated actively in the volunteer work on the recreation hall and a lot of people learned how and where to use caulking and polyurethane foam. It certainly helped according more credibility to KEEP's work.

13. Poster session. The participants to the conference were mostly the more informed leaders of the communities. They expressed interest in the activities, with special attention to the specific materials used by KEEP. There was also a desire to know where renewable energy sources fitted in such a project. These energies, often discussed in the media, are not too well understood but they generate interest.

3.5.2 Technology Transfer Techniques

At this point in the project, it appears that the technology transfer techniques can be classified as follow:

Most successful:
- permanent resource person on site
- display posters
- open house
- hands-on training
- video
- FM announcement
- experts opinions (eg. -nurses, mayor, etc.)

Mitigate:
- caps, buttons and T-shirts to a logo

Less successful: - written material
- "join in" while KEEP works on your house or any volunteer work

3.5.3 Costs figures and pay-back period

Using the cost figures relative to the thirteen buildings winterized in Kuujjuaq, as compiled in Tables 3-3 and 3-4, we obtain a rough estimate of the cost of retrofitting one of the houses during KEEP.

Table 3-3 Material used by KEEP in Kuujjuaq

Description of material	Quantity used	Cost estimate
Spring weatherstripping	33 packs (2.5)	339.57
Door sill weatherstripping	30 units (2.3)	80.70
Clear plastic	2 1/2 boxes (0.17)	151.31
Fing 'R' lock frame	6 boxes (0.50)	398.64
Electrical outlet pads	2 packs	5.10
Two-sided tape	18 packs (1.40)	45.90
"V" type weatherstripping	12 boxes (0.90)	201.48
Silicone caulking	79 tubes (6)	232.26
Sista insulating foam	25 cans (2)	324.00
		1,778.96
	Approximate cargo cost	550.00
	Total	2,328.96

Table 3-4 Trainees salary expense
in Kuujjuaq

Trainee	Period worked	Expense
D. Cooper	46 days + 5 1/2 hours	$ 2,735
M. Gordon	31 days + 7 hours	2,550
	Total cost:	$ 6,285

The total cost for winterizing 13 buildings in Kuujjuaq comes out to $ 8,614., a unit cost of $ 663.. (This amount does not include the coordinator and consultants fees because they are start-up expenses.)

To estimate the pay-back period of these measures, an attempt was made to use the actual heating costs for the project's duration, form September to December 1984. However, this exercice does not lead to conclusive results and the calculations are only presented in Appendix C for the reader's information. It is no surprise that such a short comparison period is not enough to obtain significant information, more so because the buildings were winterized at any time during the fall, not necessarily at the beginning. The pay-back is therefore estimated here using the data gathered in the data base report.

The annual heating cost taken $ 2,000. for a house in Kuujjuaq (Data Base Report p. 57) and the projected savings on the heating cost being 35 %, from the HOTCAN simulation of a 50 % infiltration reduction (Data Base Report).

With these data base figures, the estimated annual savings of the winterization measures comes out to 35 % of $ 2,000. = $ 700.00. The pay-back is then calculated to be a little less than a year, which is very good. It does not include the improvement of the house comfort or the positive impact of new job creation, which add even more positive effect to KEEP's activities.

3.5.4 Life-expectancy of installed material

The calculation of the pay-back period takes for granted that the material remains efficient in time. Such an assumption has to be verified before it can be taken as true, but too little time has passed since the end of the project to be able to do so. However, in February 1985, a detailed visit of the winterized houses of Kangirsuk was performed by the local house-doctor Jeannie Nungak. Her observation are gathered in Table 3-5.

Table 3-5 Inspection of winterized houses
In Kangirsuk (February 1985)

HOUSE NUMBER ➔ QUESTIONS ⬇	109	113	120	122	120	132	141
How many broken windows panes?	0	0	0	0	0	0	0
How many storm windows were installed?	6	6	7	7	0	7	6
How many storm windows have broken plastic?	0	4	0	6	0	0	0
How many storm windows have been removed?	0	1	1	0	0	0	0
How many windows with storm windows are frosted?	little bit 2	little bit 3	little bit 1	little bit 3	little bit 3	little bit 2	little bit 2
How many windows are left opened?	2	2	2	2	all	2	2
On how many windows the "V" type was removed?	0	0	0	0	0	0	0
How many doors have been weatherstripping?	2	2	2	1	2	2	2
How many doors have a broken door-step weatherstripping?	1	0	0	1	0	0	0
How many doors have broken side weatherstripping?	0	0	0	0	0	0	0
How many doors have "V" type removed?	0	0	0	0	0	0	0
How many doors do not close well?	0	0	0	0	0	0	0
How many straight holes to the outside, unplugged?	0	2	0	0	0	0	0
Do house tenants find it more comfortable in house? (yes or no)	yes	yes	yes	yes	yes	yes	yes
Date of survey (85-02-13)							
Survey performed by: Jeannie Nungak							

As she points out, the installed material is either in excellent condition or in very bad shape, which depends mostly on how much the tenants care about it. (In Kangirsuk, two of the houses seem to demonstrate a lack of concern for the material). The other house tenants mentioned that KEEP's work had helped keep the house warm, the only problem being some storm windows "popping" out of place in high wind conditions.

In Kuujjuaq, such a detailed visit could not be performed but the coordinator did a fast visual inspection in ten of the houses. The conclusions were here again the same. Where the house tenants were concerned, all the material was in excellent condition. In some other houses, it had been broken or removed, and the situation was almost as if nothing had ever taken place in the house.

Although it is still early to conclude, it appears that the material's quality is adequate and that it's life expectancy will depend upon the people's concern. Hopefully, motivation to keep the material in good condition will develop as it becomes known that it improves the house comfort. Incentives to maintain it could be built-in, for example, a small cost for replacement or broken parts could be charge as energy conservation becomes more a permanent part of housing maintenance.

3.6 Interpretation and recommendations

3.6.1 Technical Training

It is this portion of the project which received most of the time and energy because it turned out that, if hands-on training produces a very good response, it also asks for a lot of physical participation and time. In the occurence of the repetition of this training, the use of a detailed training manual and a formation video would greatly help. It is therefore strongly recommended that:

1. A detailed training manual, in Inuktitut and English, be prepared. The manual should also include: a description of the material used, its cost and where to buy it; basic carpentry skills for fixing doors and windows; general information on house temperature and dryness and how they relate to health.

   A training manual was prepared by KEEP's personnel and a copy is in Appendix E. It will of course change as use shows which information is lacking or what type of drawing in more easily understandable. Such a manual should be a dynamic tool rather than a rigid, static one.

2. A formation video be prepared from the already available filmed activities. By changing the comments and putting more emphasis on the technical descriptions, the video produced for KEEP could become a formation tool. This could be done at a fairly low cost since the filmed material is already produced.

The tasks that were performed by the house-doctor teams in both communities were found to answer a definite need. There is actually no personnel taking care of those specific tasks or even prossessing the relevant knowledge. Creating permanent job openings for house-doctors in all communities would not only provide additional employment and save on energy cost, it would also keep the housing stock in a better condition. It is therefore recommended that:

3. Permanent house-doctor jobs be created. The communities wishing to participate would benefit of KEEP's experience by using the manual and video, combined with expert's advice. A cooperation with Canada Manpower could help assume the formation costs for all the communities.

3.6.2 General Information

It is quite obvious that a ten-month project in two of the thirteen communities could only chip at the tip of the iceberg representing the whole energy concept. It is also quite difficult to judge, at this point, the impact of KEEP, since the energy monitoring has not been completed and the video has not yet been released. However, some conclusions and recommendations concerning the general public's response can be made.

The open house as an introductory activity gave good results and the experience might have been interesting to repeat. However, it was noticed that neither the population nor the trainees really wanted to discuss such matters outside normal work hours.

The use of the local communication media, Taqralik and the FM radio, must be included in any project. However, it is better to present concrete activities than theoretical considerations and the media lend themselves better to information than training.

The question of dry air in houses and its relation to health problems was mentioned often by the population, a sign of their concern for health. It appears needed that the nurses of the communities be informed on the nature of the work done in the houses and how it can reduce the excessive dryness.

The school teachers should also receive background information, not only on winterization, but also on the whole concept of energy conservation. They would then be better equipped to use an energy oriented student kit. The Kativik School Board also expressed its interest in developing the concept as part of a permanent portion of the curriculum.

The community councils should not only be informed about energy conservation techniques, they should also be provided with the proper materials or pressure should be put on the local stores to offer them. The materials are not readily available in the North; the fact was mentioned by several different persons. There is a need to replace or maintain such materials and they should be available.

Another consideration regarding the general public is the financial aspect of the whole energy business. Although home comfort was found to be a good incentive to energy conservation, it remains limited. The tenants, even without paying the energy bills, are aware that a dollar sign is attached to energy. Some people, often council members, have expressed the desire to know if the savings resulting from a more efficient use of energy could be reinvested at the community level. This aspect is worth some thought.

The North-West Territories have implemented a user-pays program for electrical energy. If the household electrical consumption goes beyond a certain level, the tenants receive an invoice for some symbolic amount, a small unit price for each extra kWh. This program has apparently produced some significant savings and made the tenants more aware of the cost related to electricity. Northern Quebec could benefit from their experience.

A preliminary step towards a user-pays program would be to send each household modified copies of their electricity and fuel invoices, presently received directly by the council. On those copies, the tenants could find explanations concerning the energy costs. Later, a user-pays program similar to the one in the N.W.T could be enforced. It could also include a return of any savings as a complement to the excessive consumption surcharge.

Finally, in dealing with energy matters, Northern groups such as KRG and Makivik should act as models of good energy management. Both groups should retrofit both their offices and their employees' residences and encourage. Energy-wise management practices in their buildings.

In conclusion, the following recommendations would greatly improve the general public's energy awareness:

1. Preparation of a series of radio shows and articles on energy facts
2. Information to nurses and teachers
3. Preparation of a school energy syllabus
4. Organization of energy conservation material supplies
5. Implementation of a user-pays program
6. Enforcement of energy management plans for KRG and Makivik

3.6.3 Energy Conservation

At this point in the project, it is still too early to extract any reliable data on the financial savings generated by the project. It is however quite sure that an energy conservation project similar to KEEP would promote conservation, if only by maintaining the houses in better condition.

The unit cost to winterize a house, estimated for now at $ 663.00 in section 3.5.3, will decrease as the trainees become more autonomous and experienced. Also, as most of the old houses are renovated or winterized, the maintenance will involve smaller cost than winterization. It is also important to emphasize that KEEP has apparently triggered a lot of interest in energy conservation and that the time would be chosen to continue the project. A longer term project would have even more impact, especially if it used the credit acquired by KEEP.

To assure a long-term energy conservation impact, the following activities are strongly recommended:

1. Monitor the effects of the program on the energy consumption of the buildings to be able to quantify the impact.

2. Organize the material supplies for maintenance of the retrofitted houses through the councils or the local stores.

3. Encourage the winterization of houses in other communities through the creation of permanent house-doctor jobs.

4. Include electricity in the conservation activities by an economy campaign concerning electrical home appliances.

5. As a sequel to energy conservation activities, encourage resource conservation in the municipalities. For example, the municipal garages could receive technical assistance to install incinerator using the virtually free energy found in packaging and waste oils.

6. Also to encourage energy conservation, a heat recovery demonstration project on one of Hydro-Quebec's power plant should be organized. The chosen municipality could be encouraged in applying on ENERDEMO for financial assistance and should communicate with HQ.

4.0 ENERGY PLANNING

4.1 Objectives and Scope

The objective of developing an energy plan for each community is to provide an essential planning tool to KRG, Makivik and other organizations concerned with the energy and economic future of the region as a whole. A further objective in the development of the energy plans was to undertake the process in a participatory manner, that is, the major input to the plans would be from the people in each of the communities so that community needs would be strongly reflected in the final outcome.

The energy plan for each community was intended to cover such areas as:

- community perceived energy needs
- identification of energy flows through the community
- identification of elements of energy use unsatisfactory to the communities
- quality of life aspects related to home energy use
- increasing energy use efficiency
- potential conservation savings
- identification of feasible renewable energy developments and the potential contributions
- identification of conservation and renewable energy scenarios and the resultant fossil fuel use.

4.2 Limitations

From the outset of the project, it was evident that the energy planning process would be better dealt with, not as an isolated phase, but as an integrated part of the training and community participation in formal discussions and meetings dealing with various aspects of the overall plan.

Energy is not a defined concept in Inuktitut. Thus, there was some difficulty in introducing energy conservation as a practice to be followed in the home.

Added to this was the major problem of developing incentives for household energy conservation, given the fact that fuel oil and electrical bills are not paid by the house occupant. The major incentive used to attract interest in the project was improved comfort in the home. This posed obvious limitations to obtaining community-wide input to portions of the energy plan.

The result of all this was that most work at the community level, other than as part of the training and awareness component, was directed at community leaders who had the time and inclination to discuss relevant issues. The consensus among most community leaders contacted, however, was that, since the project had KRG sanction and that the project participants were supposed to be the "experts" in the field, these "experts" would know the best approach to take. Thus, in effect, the anticipated participatory energy planning portion of the project was in danger of becoming another imposed planning process.

Coupling the energy planning process with the training component permitted some form of community input to the direction of the plan. But, at the same time, it severely limited the scope of the plan.

4.3 Problems Encountered

Most of the problems encountered relating to the development of an energy plan have been cited above in Section 4.2. In addition, the incompleteness of the Data Base Report, as it related to energy consumption in the non-domestic sectors, limits the viability of an overall energy plan at this time.

The major project focus was eventually oriented toward community participation in home improvement to increase comfort during the winter. As a result, only limited project resources went into preparation of an energy plan for each community.

4.4 Interpretation of Results

4.4.1 Status and Role of Energy Plans

The status of the energy plans for each community is more or less identical. In both cases, the orientation of the plan has been toward practical implementation through the training and community awareness program. The following original portions of the energy plan have been accomplished:

1. Community perceived energy needs. These were elicited through discussions with community leaders and through an administered auditor household questionnaire.

2. Identification of energy flows through the community. The Data Base Report, with all its limitations, identifies household energy flows from the supplier to the consumers.

3. Identification of elements of energy use unsatisfactory to the communities. This information was determined at the same time and by the same process as in item 1, above.

4. Identification of quality of life aspects related to home energy use. Improved home comfort was identified as the major concern of most families contacted. Conservation of energy, in the form of improving the air tightness of the house to stop cold drafts and the escape of heat, proved to be a most promising aspect with increased use of electrical appliances, especially those that would become available in new or renovated homes.

5. Increasing use efficiency. Use of home heating oil was the prime focus of improving efficiency of use. The energy conservation measures undertaken in each of the 19 houses and 4 other community buildings, coupled with improvements made to furnace efficiency in some of these buildings, should definitely improve the efficiency of this fuel its intended end-use. In addition, the HQ electrical generating facilities in each of the communities have been singled out as potential sources of usable waste heat. This waste heat could be channeled to adjacent garages or other community building as space heat.

6. Potential conservation savings. Savings due to the conservation measures adopted in the 23 buildings in the two communities are in the process of being monitored. The monitoring period should last for 12 months in order to compare fuel oil use with previous 12-month periods. Comparisons will be done on a normalized basis for all 23 buildings.

7. Identification of feasible renewable energy developments and the potential contributions. One hydro-power site has been identified by HQ as a potentially feasible development near Kuujjuaq. Wind power has not been analysed in the region of the two communities. However, it would appear from preliminary assessments of data from Kuujjuaq, to be a potentially viable form of energy for the production of electricity. If a recommended weather station is installed in Kangirsuk, the wind data from that site could be used to assess its potential. Once these assessments have been undertaken, the potential economic contributions of wind power both communities can be determined.

4.4.2 Implementation Through Training

The training and community awareness portion of the project received major emphasis. For reasons outlined above , it was decided to focus most of the effort originally anticipated for the development of an energy plan to practical training and de facto implementation of a portion of the energy plan. The result was that several people in the two communities were trained to be house-doctors and 19 households received assistance in implementing retrofit energy conservation features. The occupants of these same houses, plus others who came to open house meetings, received instructions on how to further reduce heat loss by better door and window management procedures.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Overall Impact of KEEP

Work on this project encompassed the following five major areas:

1. Developing people's awareness of the use of energy in housing and other buildings through radio talk shows, open house, community work bees, poster displays, magazine articles, retrofit work on houses and other buildings and preparation of energy conservation kits for the schools. This sensibilization concentrated on the need for energy conservation, the level of skills needed for simple house repairs and the costs of such repairs.

2. Undertaking building rehabilitation in three communities. Twenty-three buildings in Kangirsuk and Kuujjuaq were retrofitted with infiltration reducing materials. In addition, two houses in Tasiujaq were weatherstripped and caulked.

3. Developing an initial energy data base for Kangirsuk and Kuujjuaq. The data base summarizes supply and consumption of energy in both communities, most specifically as it relates to housing.

4. Developing and initiating an energy training program in Kangirsuk and Kuujjuaq. Five people were trained to do simple home maintenance and repairs to reduce infiltration and heat losses. Training materials and a video of the training program were prepared. The most effective training is on-site, hands-on training and experience revealed that the most effective team of house-doctors comprises one woman and one man.

5. Initiating the creation and implementation of an energy plan for the two communities. Housing energy losses have been identified as the first target in the implementation of the energy conservation phase of energy plans in both communities.

5.2 Interpretation of Results

The data base is not complete. However, its status reflects the resource and time limits imposed by the project. Presentation of a complete energy data base report could easily have absorbed all the resources of the project, given the accessibility of data and the existing level of treatment of the data has reached its goals.

The training program was very satisfactory in Kangirsuk due to the size of the community and the continued presence of a project member in the village. Some difficulty was encountered in Kuujjuaq, particularly with continuity of the trainees. This reflects the differing social situations in the two communities in that more for distracting activities open to inhabitants of Kuujjuaq. The process of selection of the training sites perhaps favored success more in Kangirsuk than in Kuujjuaq. It was further discovered that a satisfactory training program requires constant supervision at the beginning and a good infrastructure as it relates to the availability of training materials.

The KEEP project has definitely improved the comfort and inhabitability of the houses concerned. However, the savings due to the modifications are not yet known.

The process of informing the population about energy related concerns has not been completed. To become a part of everyday life, energy concerns will have to be demonstrated to everyone in the communities on a frequent basis. One of the functions of the video and the school energy kits is to help accomplish this.

The project has demonstrated the potential for, and community interest in, new job creation and better home maintenance.

KEEP has also revealed that there are several new energy related needs in these and other communities:

- availability, on a continuing basis, at the councils or local stores of the materials required to maintain and retrofit houses
- availability of a permanent infrastructure for house maintenance and energy conservation through either KRG or the councils
- general information to the other communities on how energy conservation activities can be carried out and at what cost
- combining or linking energy conservation messages with renewable energy information that is already being discussed in the media

- availability of information on the money saving aspects of the energy conservation practices undertaken to date on the houses. The comfort incentive was an important means of introducing home energy conservation but the house occupants have become aware that if energy is conserved, money is also saved by someone. If this is the case, the money saved at whatever level can become useful leverage to promote further savings. The need here is thus two-fold: to determine how much money can be saved, and to determine the most effective way of using the savings as incentives to house occupants to increase conservation practices.

5.3 Recommendations

5.3.1 To complete KEEP's activities

In order to complete the work initiated by KEEP during the course of the present project, and in order to give more comprehensive meaning to the activities already undertaken, there are some aspects of the project that could benefit from continued effort beyond the presentation of the final report. These include:

- monitoring of the energy consumption of the houses retrofitted to date, at least until December 1985. The data is available from the councils and KRG has competent workers that could easily handle such a task.

- follow up and feedback on the performance of materials installed in the houses and community buildings, for a period of at least 12 months. The town councils are often required to visit the houses for maintenance or water sampling activities, they could visually inspect all those dwellings in a few hours and report to KRG.

- ensuring the availability of the necessary materials in Kangirsuk and Kuujjuaq so that the house occupants will be able to maintain their houses if desired. The councils could maintain a stock of the necessary items. However, the Bay and the cooperatives may also be persuaded to carry some materials for sale. (Both municipalities were left with some material at the end of KEEP)

5.3.2 For a continuation of the energy awareness development process

The project has been able to only briefly introduce the concept of energy use and energy conservation in the North. There remains considerable effort to be made before the general population becomes aware of the significant aspects of energy conservation and what they can do to affect energy use. Some of the more basic steps to follow are:

- o continue with assistance to the schools, possibly through contributions to the development of the curriculum to incorporate energy as a permanent part of the natural sciences (or other?) syllabus
- o involve and inform the population through initiating such programs as "user-pays" programs as described in section 3.6.3
- o encourage good energy management and use through appropriate modifications to much used community buildings such as those owned by KRG and Makivik
- o release the KEEP video through the communities' television network (TNI), the schools, and possibly, Inuit Broadcasting Corporation
- o leave copies of the training manual in Kuujjuaq and Kangirsuk to encourage the maintenance of the newly acquired skills
- o take advantage of the interest expressed by the CBC Northern Service in a series of morning shows on the Inuktitut radio to deal with energy matters

5.3.3 For a long-term effect on energy conservation in Northern Quebec

In order to benefit from the momentum gained during the current project and in order to ensure that the expected long-term results of energy conservation and better energy management became a part of everyday life in the communities of Northern Quebec, some near-term follow-up will be required. This includes:

- o creation of a permanent energy infrastructure within KRG by making permanent jobs out of the house-doctor positions. Some form of cooperation with Canada Manpower could be envisaged to increase the potential for a training and employment program on a larger scale for all the communities

- o involving the municipal councils in other aspects of energy conservation. For example, the municipal garages could have incineration and heat recovery facilities to take advantage of the free energy available in packaging materials and waste oils

- o gathering data on the effects of energy conservation retrofits on a longer term basis. The community of Kangirsuk could be monitored over a period of 2 years after all the houses and other buildings are retrofitted, in order to provide a community-wide basis with which to compare other Northern Quebec communities. A computerized invoice system would greatly increase the efficiency of data collection. The available energy data bank could be upgraded and organized as new information becomes available as part of this process. Computerized storage and access to energy information would facilitate assessment of data and impact of the energy program.

5.3.4 To initiate energy self-sufficiency

Energy conservation is a vital step taken on the road to energy self-sufficiency, but it alone will not remove dependence on fossil fuels by the communities of Northern Quebec. There is also the need for activities oriented toward oil substitution.

Alternative energy demonstration projects should be envisaged in the near future. Kangirsuk could be a favorable site particularly for wind energy conversion systems. The Enerdemo program of EMR is a typical example of a government assistance program that could be accessed by Northern Quebec communities to provide funds for the realization of a wind, or solar, demonstration.

In addition to the municipalities, KRG and Makivik, other organizations active in the communities should be encouraged to become involved in conservation and better management of energy. Hydro-Quebec, for example, would do well to consider the small scale recycling of waste heat from their power plants in either or both of Kangirsuk and Kuujjuaq. This waste heat could be used as space heat for municipal garages or other public buildings.

APPENDIX A

WORK STATEMENT

Study objectives

To design energy planning and training activities and to implement them in two pilot communities, so that the activities can be used as a basis for comprehensive energy planning and management in 14 communities of Northern Quebec, and so that local energy management skills will be developed and disseminated to others in the communities.

Financial management

Kativik Regional Government shall assume overall financial and administrative responsibility for the project, in consultation with other participating organizations.

Work statement

1. A study advisory committee shall be established. It will consist of one representative from each of: Energy, Mines and Resources Canada, Kativik Regional Government, Makivik Corporation, Société d'habitation du Quebec, Hydro-Québec, and when chosen, the project coordinator.

2. The advisory committee will choose a full-time project coordinator and a part-time assistant. They will be chosen based on project management criteria developed by Kativik Regional Government and Makivik Corporation. They will be paid by Kativik Regional Government.

3. The project coordinator, with the approval of the advisory committee, will choose a consultant for the initial training program of four community energy specialists. The consultants will be paid by Kativik Regional Government.

4. Two pilot communities will be chosen for in-depth study. The criteria for choosing the communities will include size, availability of people to take part in

the training activities, and replicability for other communities. The choice will be made by the project coordinator and the consultant, and approved by both Energy, Mines and Resources Canada and the study advisory committee.

5. The project coordinator with the concurrence of the advisory committee, will hire two trainees for each of the two pilot communities.

6. A data base shall be developed consisting of:

   a) Data on energy consumption.

      The data will cover both regional and community bases, for ten and five years ago, now and projecting five years in the future. The data must be grouped into end-uses and separated by fuel-type. It will include the cost of each type of fuel (with and without subsidies), size of electrical generators, base and peak loads, population and growth projections, and number, size and characteristics of buildings.

   b) Data on energy resources in the region.
      The data will include fossil fuels and hydro, tidal, wind and solar potential.

   c) Information on available and adequate energy conservation and renewable energy technologies.
      The implementation and consequences of these technologies in environments similar to that of Northern Quebec is to be examined and evaluated with reference to this situation.

   d) Information on energy technology impacts.
      Information will be obtained on the health, safety, social and environmental effects of energy conservation. Emphasis will be put on defining the link between increased life quality and efficient energy use.

7. The information base will be refined by:

   a) Identifying information gaps and evaluating the significance of missing information; and

   b) Gathering or developing the critical parts of the missing information if possible within the scope of the project.

8. A draft report will be produced on the data base. The draft will be given to Energy, Mines and Resources Canada and to the study advisory committee for comments. A final report will then be prepared. One original, reproducible version of the report will be given to each participating organization.

9. The project coordinator, the consultant, the project assistant, and the two energy trainees along with community officials will develop an energy plan for each pilot community. The process of developing the energy plan, which will be fully documented, will include:

   a) Examining the actual aspects of energy utilization which are not satisfactory for the population. The health, house enjoyment and general comfort related to energy sources (fossil and electrical) especially in houses, are to be investigated.

   b) Examining appropriate measures to increase the efficiency of the energy use. The potential energy savings achievable over the next five years through energy conservation measures will be evaluated.

   c) Developing an implementation plan. The plan will include a step-by-step plan on how conservation technologies can be introduced and implemented in the communities. Renewable energy technologies will be introduced to the community as the next step towards self-sufficiency.

10. The project coordinator, with the consultant, will design a public information and training program for a more efficient energy use in the community.

    a) Topics to be covered in the program will include, as a minimum: energy audits of buildings, oil burner maintenance, infiltration reduction techniques, glazing improvement information, and other low-cost conservation measures;

    b) The program should include: education material for schools and community information meetings and consultation.

    c) Other training programs under way or proposed in the pilot communities in particular and in Northern Quebec in general, will be evaluated to determine the possibility of collaboration.

    d) The training program will be designed to take place in one of the pilot communities, over a four-month period.

    e) As the training sessions are conducted, the project coordinator and the

consultant will develop training material. The material will be in a form that is self explanatory and easy to update and to share with the other communities. The material will be produced in English, French and Inuktitut and maximum use should be made of local communication media. A draft shall be submitted to the study advisory committee for comments before the final version is prepared.

11. The training program will overlap with some aspects of the implementation of the community energy plan. The trainees, to be known as community energy advisors, will undertake low-cost or no-cost conservation measures on selected buildings. At least one selected building in each pilot community will be a public building.

    a) Energy audits will be conducted on buildings in the two pilot communities.

    b) Oil burner maintenance will be conducted on primary heating systems in the two pilot communities and on accompanying redundant system units.

    c) Buildings in each pilot community receive more extensive infiltration reduction measures and will be examined for associated indoor air quality.

    d) Glazing improvements will be installed in buildings in the two pilot communities.

    e) Other no-cost conservation measures will be taken in buildings in the pilot communities. Strategies for encouraging and maintaining these measures will be developed.

12. A report will be prepared on the conservation work done in the communities. A draft of the report will be presented to the study advisory committee for comments. A final version will then be prepared.

13. A presentation on the study work will be made to the pilot communities.

14. A draft report on the overall study will be prepared. It will contain, as a minimum:

    - table of contents
    - abstract or summary
    - introduction
    - study objectives
    - discussion of data base
    - discussion of community energy plans
    - discussion of training
    - discussion of implementation of community energy plans

- results obtained and savings projected
- problems encountered
- proposed solutions
- suggestions on how other communities can make use of the information and procedures.

15. Comments shall be obtained on the draft report from both Energy, Mines and Resources Canada and the study advisory committee. A final report will then be prepared.

16. One original, reproducible version and five copies of the final report will be given to the members of the study advisory committee.

APPENDIX B

DATA BASE REPORT

FOR KANGIRSUK AND KUUJJUAQ

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1.0 INTRODUCTION

1.1 History and Background

This energy data base report has been prepared as part of an overall plan to design and implement energy planning and training activities in the corporations of the northern villages of Kangirsuk and Kuujjuaq. This study was done for the Kativik Efficient Energy Program (KEEP) under the management and coordination of the Kativik Regional Government (KRG). Preparation of the original draft of the report was undertaken during the period April through August, 1984.

1.2 Statement of Purpose

The purpose of this report is to assemble and organize in one document data on energy supply and consumption which can be useful in future energy planning and impact assessments for the two communities.

1.3 Target Audience

The report presents energy supply, consumption and cost data. Much of the information is essentially unanalyzed and is also given in units easiest to access. The reader should be aware of these limitations to the data presentation and should not expect to directly extract comparative information in presently accepted SI units.

1.4 Information Sources

Information for this report has been obtained from a wide range of sources using a variety of gathering techniques. Computerized literature searches of five data bases and internal documents from Societe d'Habitation du Quebec (SHQ) and Hydro Quebec (HQ) files were consulted to set the context for the report. A review of this information and on-going studies in Northern Quebec by private,

institutional and governmental agencies revealed the scattered and essentially uncoordinated efforts in this area to date. Information missing from these sources was obtained through personal communications with researchers, other individuals and companies working in Northern Quebec. A prime source of information was an auditor administered household questionnaire. The most useful energy data was located in individual house records maintained by the community councils, SHQ, HQ and other energy suppliers and users such as Shell Canada and Air Inuit. Much of this information was abstracted by hand from the individual files.

1.5 Limitations of the Report

Due to time and money constraints this report has focused primarily on the residential sector and has only nominally addressed the industrial, commercial and transportation energy sectors. Some non-residential community buildings have been included in the energy use data base. The logic for limiting the study in this way was that the residential sector is by far the most important energy consumer in the communities in question and the data is more accessible from both suppliers and consumers than comparable data from the other sectors.

Historical data on energy supply and consumption has been obtained only as far back as 1981 due to a lack of accessible records. SHQ assumed responsiblility for housing in Northern Quebec in 1981. Prior to that time very few useful records were maintained on residential energy consumption in the communities. The data that is available in some instances suffers from incompleteness and time related inaccuracies. However, in gross, the data presented has significance perhaps not in the specification of trends evident over the short time span, but as the first few data points in a longer term data accumulation process.

1.6 Scope of Report

This report covers historical, present and future energy supply and consumption in the communities of Kangirsuk and Kuujjuaq. Tables, charts and graphs are presented on electricity and fuel oil supplies and consumption, household energy consumption patterns, costs of energy and

some motor vehicle consumption statistics. Information is presented on relevant energy conservation and renewable energy technologies and resources, their impacts and potential feasibilities. In addition, population and other demographic data have been presented for each of the communities.

2.0 DATA RELEVANT TO KANGIRSUK

2.1 Background Data

2.1.1 General Information

The community of Kangirsuk is located on the northern bank of the Payne River, 13 km from its mouth. The village itself is built on the eastern shore of a cove located along the river. Hunting, fishing and trapping still play a major role in daily community life and an abundance of arctic char and eider ducks attract many summer tourists. It is one of the largest villages on the West coast of the Ungava Bay. Kangirsuk is situated above the tree line which ends at the village of Kuujjuaq on the 58th parallel. Figures 2-A and 2-B locate Kangirsuk in Quebec and indicate the layout of the town around the cove in the Payne River.

Location
Latitude : 60°00' N
Longitude: 70°00' W

Population: 255 (1982) Households: 54 Inuit families

Transportation
Air: Air Inuit flies in twice a day.
Road: There are 2.1 km of community streets.

Climate
Typical of subarctic regions, with long, cold and dry winters and short, cool, wet summers, Kangirsuk is characterized by storms and unsettled weather in spring and fall.

Table 2-1 Climatic Data for Kangirsuk

Avg. Yearly Temperature	:	- 6.6°C
Avg. Temperature, January	:	-22.6°C
Mean Daily Max., January	:	-18.4°C
Mean Daily Min., January	:	-26.7°C
Avg. Temperature, July	:	7.9°C
Mean Daily Max., July	:	12.3°C
Mean Daily Min., July	:	3.5°C
Frost Free Days	:	40
Total Precipitation	:	400 mm - 40% is snow
Depth of Permafrost	:	185+ m
Active Permafrost Layer	:	0.7 - 2 m

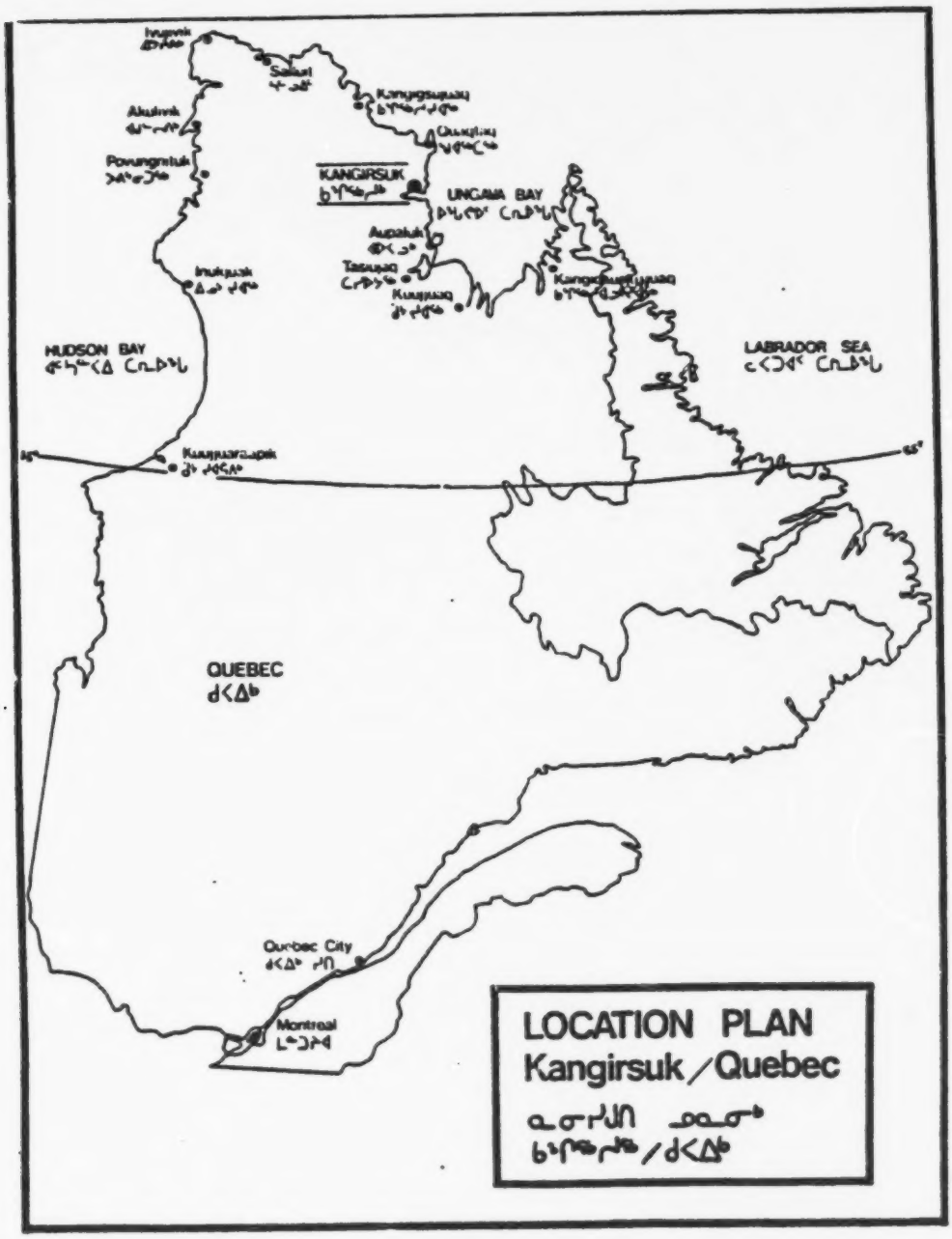


Figure 2-A Location Plan for Kangirsuk

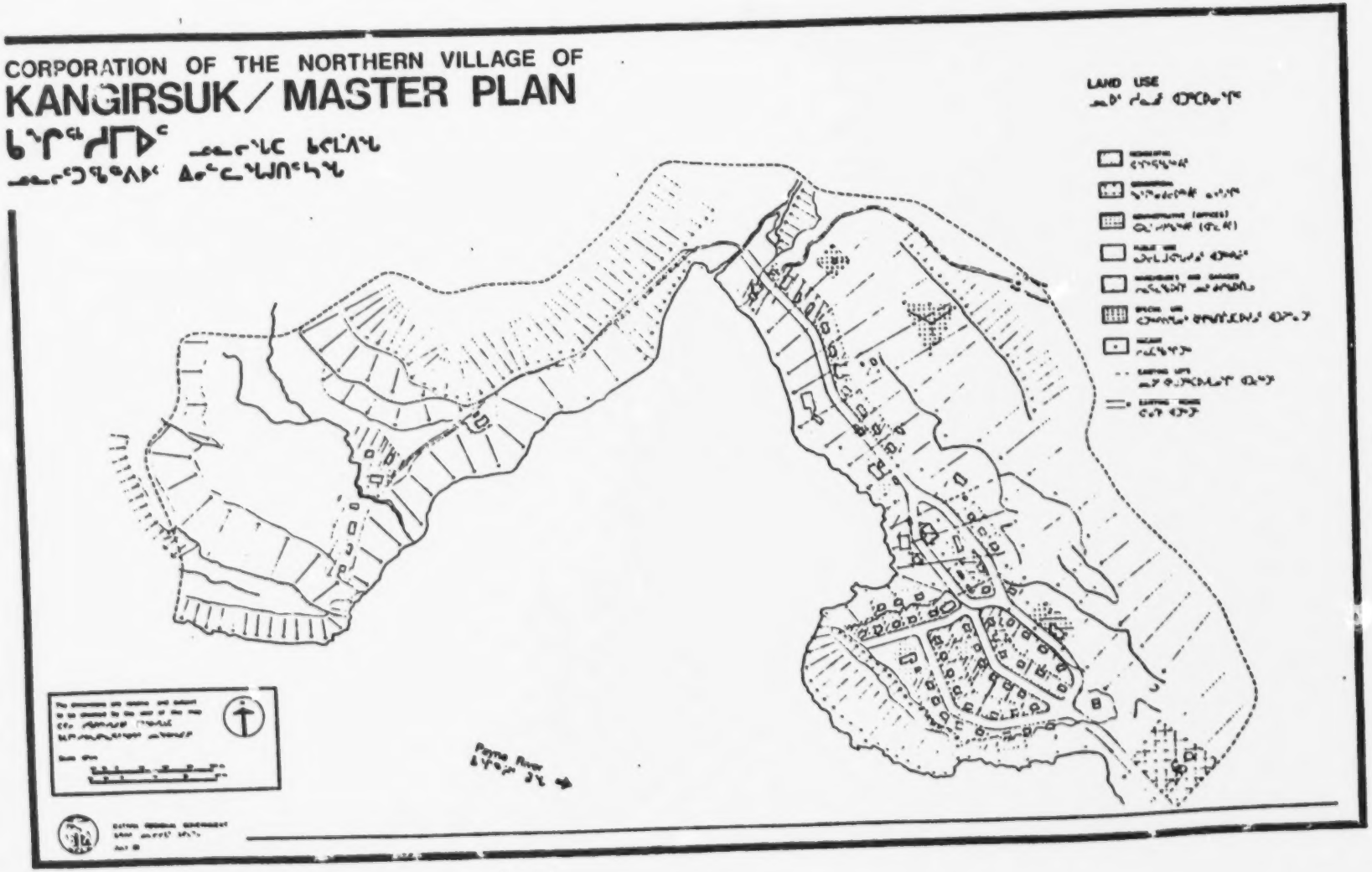


Figure 2-B Master Plan for Kangirsuk

2.1.2 Population Trends

Population data has been extracted from the Corporation of the Northern Village of Kangirsuk/Master Plan, September 1982. Table 2-2 gives the population statistics based on historical records from 1966 through 1982. Data for 1983 through 1992 represent projected figures based on an annual growth rate of 3.5% and an average number of persons per family of 4.7. The annual growth rate is the average growth rate for the period 1970 - 1980 and the figure 4.7 persons per family is the mean number of persons per family for the year 1982.

TABLE 2.2 Population Statistics and Forecasts for Kangirsuk

Year	Inuit Pop.	# Families	Total Pop.**
1966	171		
1967	175		
1968	180		
1969	184		
1970	189		
1973	266		
1974	273		
1975	280		
1976	294		
1977	243		
1978	253		
1979	260	55	271
1980	260	55	
1982	255	54	266
1983*	264	56	275
1984*	273	58	285
1985*	283	60	295
1986*	293	62	305
1987*	303	64	316
1988*	314	67	327
1989*	325	69	338
1990*	336	71	350
1991*	348	74	362
1992*	360	77	375

Note: * represents projected figures based on an annual growth rate of 3.5% and an average number of persons/family of 4.7 for Kangirsuk.

** includes non-Inuit members of the community

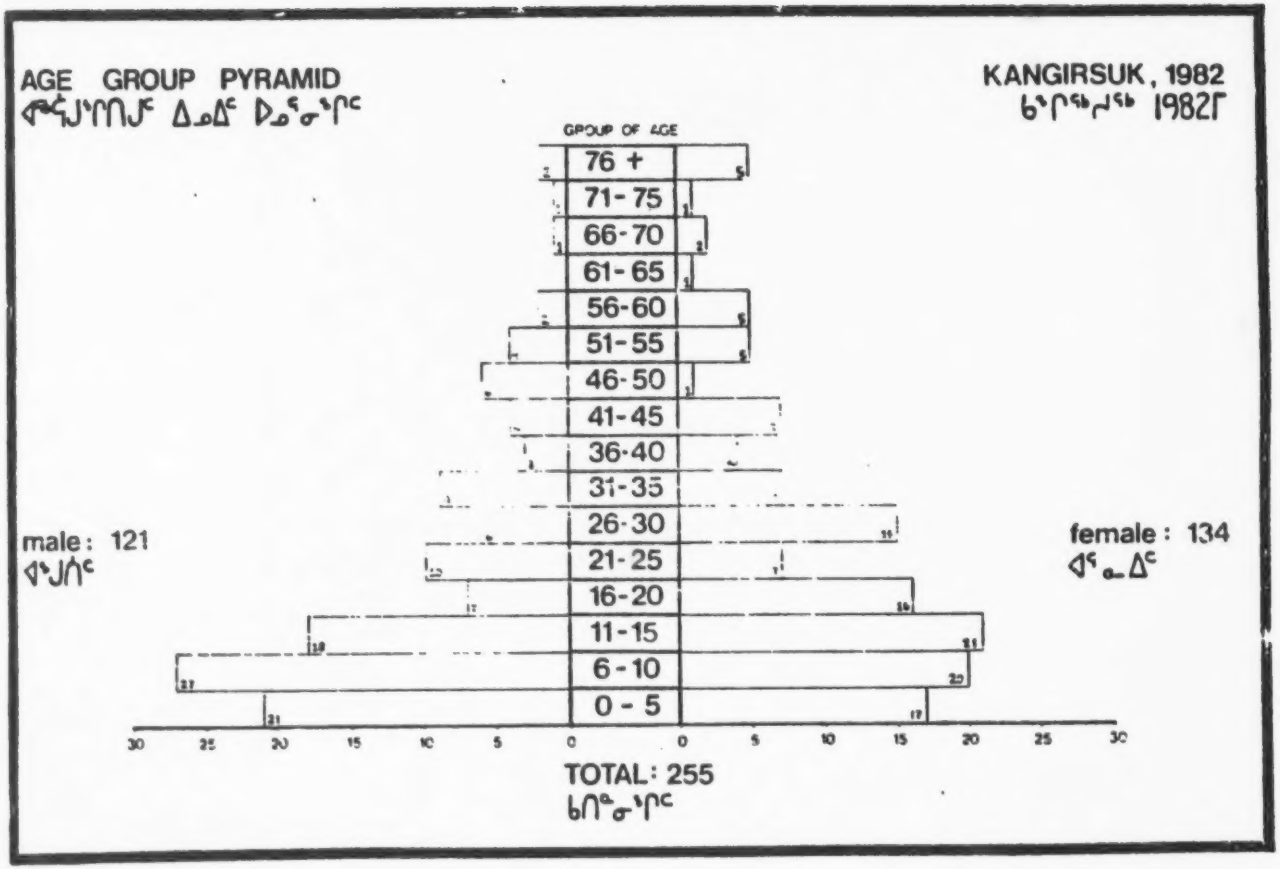


Figure 2-C Age Group Pyramid, Kangirsuk, 1982

2.1.3 Community Buildings

The number of buildings in the community and their functions is given in Table 2-3. Table 2-4 lists the number of new and renovated housing starts by SHQ from 1980 to the present. In Table 2-5 specific data from the 1982 Housing Study conducted by University of Montreal in Kangirsuk are presented. Table 2-5 includes information on type of heating and cooking system, comfort conditions in the houses, and average indoor relative humidities measured during November, 1982.

Table 2-3 Kangirsuk, Distribution of Buildings By Function

Function	Total
Residential: Inuit	54
Agencies	9
Warehouses & Garage	15
Public Services	10
Commercial	7
"Special" Uses	5
Offices	3
	103

Source: Data for this chart has been taken from the Corporation of the Northern Village of Kangirsuk/Master Plan, September, 1982. The number of residential units has been updated from 1984 data on current housing stock.

Table 2-4 New and Renovated Housing Starts by SHQ
- Kangirsuk

	1980	1981	1982	1983	1984
New	-0-	2	-0-	8	-0-
Renovated	-0-	-0-	-0-	10	-0-

Source: Data from SHQ Habitation Nordique Dossiers (1980-84)

Table 2-5 Results of University of Montreal Northern Housing Study for Kangirsuk (November 1982)

*Period of Residence	Heating & Cooking	House Comfort	Humidities %		
			Kitchen	Room	Average
10^{+}	oil furnace & stove	cold & drafty	n/a	n/a	n/a
10^{+}	oil furnace & stove	cold & drafty	n/a	n/a	n/a
1-5	oil furnace & stove	cold & drafty	49	31	40
10^{+}	oil furnace & stove	cold & drafty	54	61	58
1-5	oil furnace & stove	cold & drafty	46	53	50
6-10	oil furnace & stove	cold & drafty	69	51	60
6-10	oil furnace & stove	drafty	54	57	56
6-10	oil furnace & stove	cold & drafty	45	59	52
6-10	oil furnace & stove	cold & drafty	52	44	48
?	oil furnace & stove	cold & drafty	47	50	49
6-10	oil furnace & stove	cold & drafty	45	60	53
1-5	oil furnace & stove	cold & drafty	56	67	62
1	oil furnace & stove	cold & drafty	45	33	39
10^{+}	oil furnace & stove	cold & drafty	54	60	57
6-10	oil furnace & stove	cold & drafty	60	65	66
1-5	oil furnace	cold & drafty	43	49	46
6-10	oil furnace & stove	drafty	43	46	45
10^{+}	oil furnace & stove	drafty	56	61	59
1-5	oil furnace & stove	drafty	42	27	35
10^{+}	oil furnace & stove	drafty	50	60	55
1	oil furnace & stove	cold & drafty	62	54	58
10^{+}	oil furnace & stove	cold & drafty	53	55	54
6-10	oil furnace & stove	cold & drafty	62	58	60
10^{+}	oil furnace & stove	cold & drafty	n/a	n/a	n/a
10^{+}	oil furnace & stove	cold & drafty	38	48	43
1-2	oil furnace & stove	cold & drafty	35	59	47
10^{+}	oil furnace & stove	cold & drafty	50	54	52
10^{+}	oil furnace & stove	cold & drafty	56	47	52
10^{+}	oil furnace & stove	drafty	60	48	54
6-10	oil furnace & stove	drafty	51	52	52

* Number of years of residence for current occupants.

2.2 Energy Supply

2.2.1 Fossil Fuel

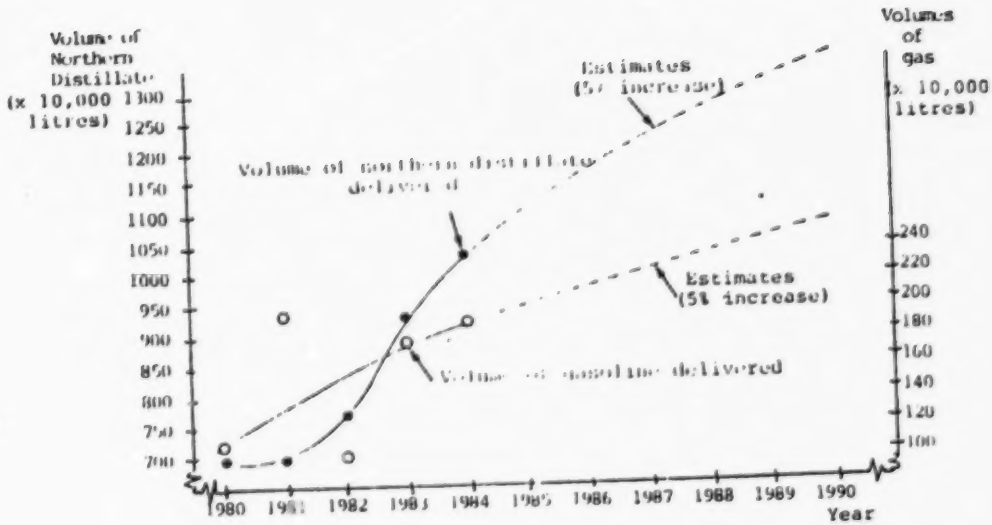
The major energy supplies to Kangirsuk are two types of fossil fuels, both supplied by Shell Canada. The community receives Shell northern distillate as furnace oil and regular leaded gasoline for transportation needs. Figure 2-D presents the actual volume of these two fuels delivered to Kangirsuk from 1980 to 1984. Shell Canada's estimate of 5% annual increase in the sales of both fuels is also presented as the best estimate of projected supply through the year 1990.

2.2.2 Electricity

The electricity supplied to the community, although a derived energy form since it is based on the use of northern distillate, is given in Figure 2-E. Data is presented as kWh produced by the HQ generators on a monthly basis for the 18-month period ending in March, 1984. Oil consumption to produce this electricity is shown on the same graph. No electricity supply projections have been shown on this figure, however it is anticipated that electricity production will keep pace with consumption which, for the SHQ houses at least, has increased an average of 35% per year from 1982 to 1984.

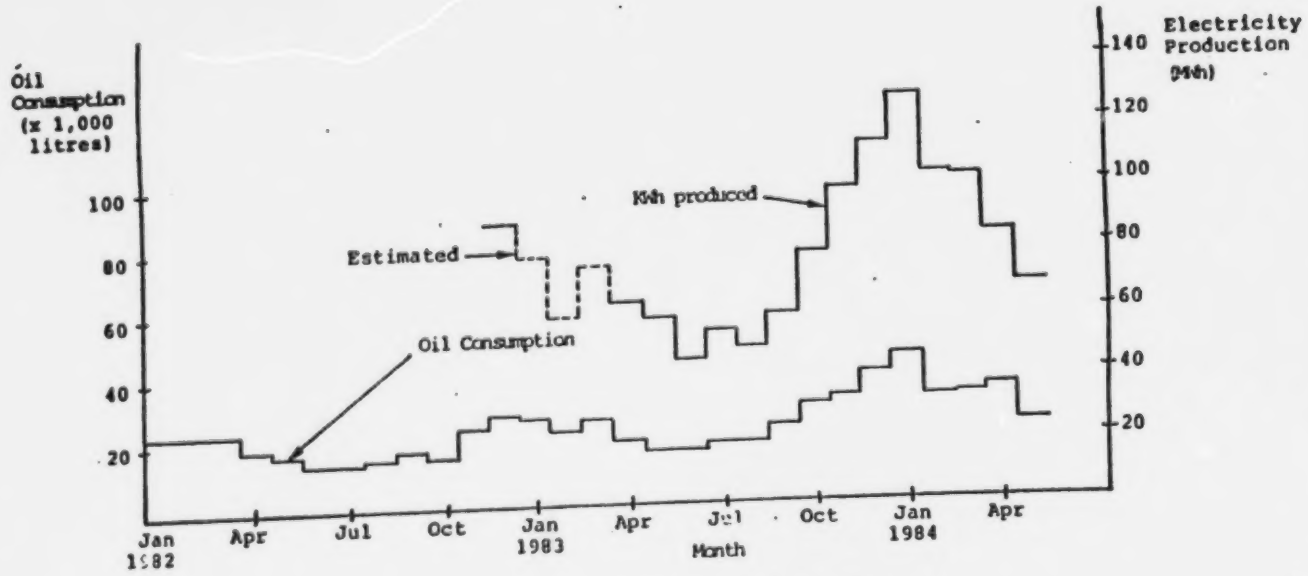
2.3 Energy Consumption

Energy consumption data presented below for Kangirsuk comprises only furnace oil and electricity use for SHQ housing over the period 1982 to 1984. Other data is available, however it is difficult or virtually impossible to access. For example, neither individual householders nor fuel suppliers were able to provide records of fuel consumption for personal transport. Nor were the researchers able to access fuel consumption records for non-SHQ or non-Council buildings. Due to time and resource constraints it was decided to focus on the residential energy sector. This sector is by far the most important energy consumer in the community. The limitation to SHQ housing was again because the



Source: letter from Shell Canada, 27 July, 1984, see Appendix A

Figure 2-D Fossil Fuel Supplies to Kangirsuk 1980 to 1990



Source: Hydro-Quebec monthly production reports for Kangirsuk.

Figure 2-E Monthly Oil Consumption and Electricity Production at Kangirsuk's Hydro-Quebec Generating Station

information was available in the community itself or easily accessible through written communications. SHQ housing represents 86% of the total buildings in the residential sector and thus is a representative indication of the gross energy consumption pattern for the community as a whole.

Nevertheless it is recognized that the total energy consumption picture is incomplete and effort should be expended at some future time to attempt to fill the information gaps.

2.3.1 Fossil Fuels

Fossil fuel consumption data is presented for heating oil used in SHQ houses. Table 2-6 gives individual house consumption records for three years. Included in the table are the total heating oil consumption for each year, the mean oil consumption for the houses and the standard deviation of the data presented about the mean.

Table 2-6 Heating Oil Consumption For SHQ Houses in Kangirsuk (litres)

House #	1984**	1983	1982	House #	1984**	1983	1982
101	3640	6644	3749	128	--	--	5263
102	1509	5614	5722	129	1804	4031	3000
103	2450	4791	4377	130	--	--	--
104	2338	4007	4493	131	2179	4842	6389
105	2444	--	4621	132	3155	8250	6339
106	2467	5127	4548	133	2305	5393	4625
107	2388	3872	3751	134	2486	6532	4919
108	2262	3839	3955	135	2114	4977	4848
109	2179	5158	4552	136	2582	5323	6690
110	2252	4925	4964	137	1383	4434	5106
111	1246	5016	4987	138	2326	4370	5827
112	2292	5463	4317	139	2775	5170	6608
113	2512	5707	5182	140	2493	4971	6048
114	3198	6654	6417	141	2411	6511	5728
115	1728	5394	6247	142	1234	4409	5460
116	2912	5813	7529	143	2227	4762	--
117	2410	4723	6252	144	3996	5000	5358
118	3130	5630	8285	145	2338	5059	6509
119	3056	5102	5233	146	2960	4864	6112
120	2988	6472	6973	147	3142	5410	5695
121	2660	8746	8666	148	720*		
122	4185	6257	--	149	848*		
123	3184	--	6366	150	711*		
124	2317	3922	4920	151	703*		
125	2201	5132	5241	152	579*		
126	1407	4113	5512	153	613*		
127	3946	4014	4162	154	691*		
				155	701*		

	1984	1983	1982
Total:	113,211	226,443	241,549
n :	45	43	44
$\bar{x}$:	2516	5266	5490
s :	678	1057	1167

NOTE: * Year incomplete, data not included

** 1984 data is incomplete

Heating oil consumption in Table 2-6 is incomplete for the year 1984, since it contains data only for the first four months of the year. In order to estimate the full year's consumption we have assumed a similar pattern of monthly use as in 1983. From the 1983 Kangirsuk fuel oil consumption records, 10 houses were selected at random. Their fuel oil consumption for the first four months were totaled and compared with their total fuel oil consumption during 1983 to obtain a multiplication factor. This factor was determined as follows:

$$\frac{\text{total consumption for 1983}}{\text{total consumption for first 4 months}} = \frac{49{,}439}{22{,}131} = 2.23$$

This multiplication factor was then used to estimate total 1984 fuel oil consumption as follows:

total consumption for
45 households for 1984 = total of first 4 months x 2.23
= 113,211 litres x 2.23
= 252,905 litres

Houses 148 through 155 are new duplexes which were occupied in the late winter and spring of 1984, thus heating fuel data represents only one or two months of usage. Consumption for the remainder of 1984 for these houses is assumed to be the average consumption per household for that part of the year for all other SHQ houses in the data sample. To calculate this latter figure, the following is presented:

assumed total yearly
consumption per household = (total for first 4 months) x 2.23
= 2516 x 2.23 (See Table 2-6)
= 5610 litres

thus total/household for
remainder of year = 5610 - 2516 litres
= 3094 litres

for 8 households, total
for remainder of year = 8 x 3094
= 24,752 litres

The total 1984 oil consumption for these eight houses is thus the sum of the recorded data in Table 2-6 plus the estimated 24,752 litres calculated above.

i.e. 5566 + 24,752

or 30318 litres

This figure is then used to adjust the total consumption for 45 households given earlier.

total consumption for all SHQ houses
for 1984 = 252,905 + 30,318 litres
= 283,223 litres

Total yearly consumption of domestic heating oil in SHQ houses is resumed in Table 2-8 and plotted for the years 1982 through 1984 in Figure 2-F(a).

Annual costs for this domestic fuel oil consumption were calculated using Shell Canada's unit price for fuel oil with a pre-paid discount and half yearly consumption volumes. These figures are given in Table 2-7, summarized in Table 2-8, and plotted in Figure 2-F(b).

The three years of furnace oil consumption presented offer little data from which to make projections, particularly considering the scatter of points for actual volumes and costs. The low growth projections shown, that is, curves drawn through the 1982 and 1984 data points, is comparable with Shell Canada's estimated increases in volume of consumption and cost. The high growth estimates simply use two data points, the median of 1982 and 1983 data, and the 1984 data point. Normalized volume of consumption decreases slightly as would be expected with gradual improvements in the thermal performance of the houses. Normalized actual costs are on the increase at an approximate rate of 5%

per annum. However, in terms of 1981 dollars, the normalized cost is decreasing at about 3% per year.

Table 2-7 Annual Quantity and Cost of Heating Oil Consumed in SHQ Houses in Kangirsuk

Year	Period	Volume (litres)	Unit Price with Prepaid Discount	Amount	Total Annual Costs	Total Annual Costs in 1981 $
1982	Jan-June	84,090	0.4200	$35317.80	$110,347	$98,454
	July-Dec	157,459	0.4765	75029.21		
1983	Jan-June	75,068	0.4765	35769.90	$112,396	$93,738
	July-Dec	151,375	0.5062	76626.03		
1984	Jan-Dec	283,223	0.5123*	145,095.14	$145,095	$114,625

Note: * average for 1984 from Shell Canada information.

Table 2-8 Summary of Heating Oil Consumption -- Kangirsuk

	1984	1983	1982
Quantity Consumed (x 1000 litres)	283.2	226.4	241.5
Normalized Consumption ($l/m^2/DD$)*	.0087	.0087	.0090
Actual Cost (x 1000 $)	145.1	112.4	110.3
Normalized Cost ($\$/m^2/DD$)*	.0045	.0043	.0041
Cost in 1981 Dollars (x 1000 $)	114.6	93.7	98.4
Normalized Cost in 1981 Dollars ($\$/m^2/DD$)*	.0035	.0036	.0037

Note: * Calculated using an average heated floor area per house of 65.8 m^2 for 1982 and 1983 and a total weighted heated floor area of 3620 m^2 for 1984 since during this last year 45 houses were occupied for three months and 53 houses for nine months. The yearly heating degree days (DD) for Kangirsuk were estimated from monthly temperature records available for Kuujjuaq. A correction was applied to the Kuujjuaq temperature information based on data interpolation in long term records for Kuujjuaq and Quartaq. (See Appendix D, page D-23.)

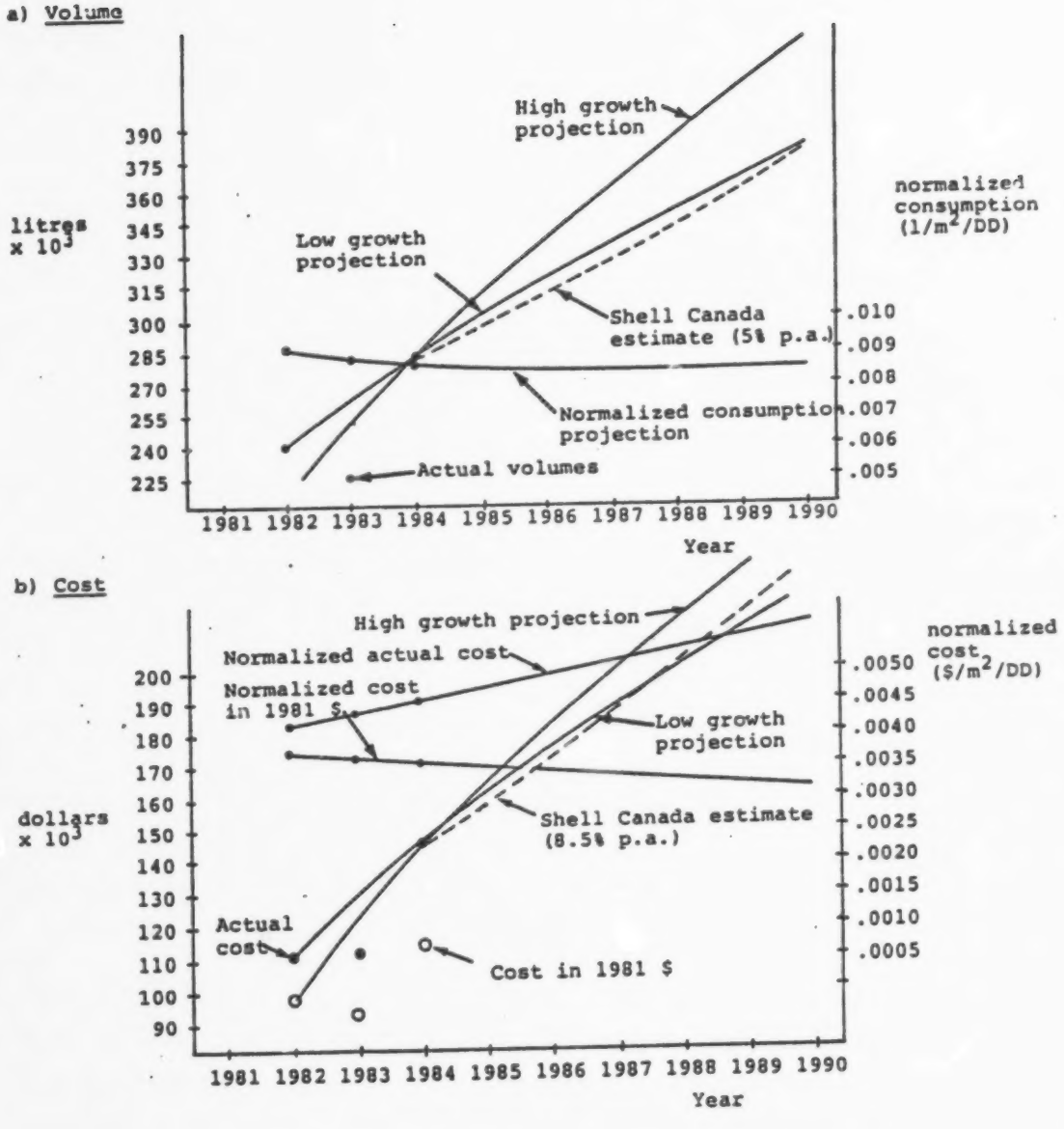


Figure 2-F

Furnace Oil Consumption and Cost - Kangirsuk

Sample Household Fossil Fuel Consumption Patterns: Three SHQ housing units were selected for a graphical plotting of their heating oil consumption on a bi-monthly basis over a 16-month period. [See Figures 2-G(a) and 2-G(b).] These houses were randomly selected from each of, and to represent, the following three categories:

household #1 - early construction, unrenovated (heated floor area is 59 m^2)

household #2 - early construction, renovated during data period (heated floor area is 59 m^2 before renovations and 70 m^2 after)

household #3 - recent construction (heated floor area is 124 m^2)

Heating oil consumption is for all domestic purposes including space and water heating and cooking where relevant in each household. All data is taken from individual SHQ house records maintained at the Council of the Northern Village of Kangirsuk. Data is only an estimate of consumption since it has been obtained from oil delivery records which do not accurately reflect actual consumed quantities during the specified period. An average daily oil consumption was calculated for each period between deliveries and the average daily totals summed over the approximately two month period equivalent to the Hydro-Quebec electricity billing period for these same households.

No attempt was made in selecting the houses to find households with similar occupancy patterns thus no rigorous comparisons can be drawn from the data presented. Nevertheless, it is interesting to observe in the results displayed in Figure 2-G(a) that, in general, the renovated and newer (and thus larger) houses use more heating oil year round than the unrenovated, older houses. However when the data is normalized to the heated floor area, as in Figure 2-G(b), it is evident that the new house uses significantly less fuel per square metre of living space than both the older and the renovated buildings. Although more data is required to draw conclusions about these households, it would also appear that the renovated house uses less fuel per unit floor area than

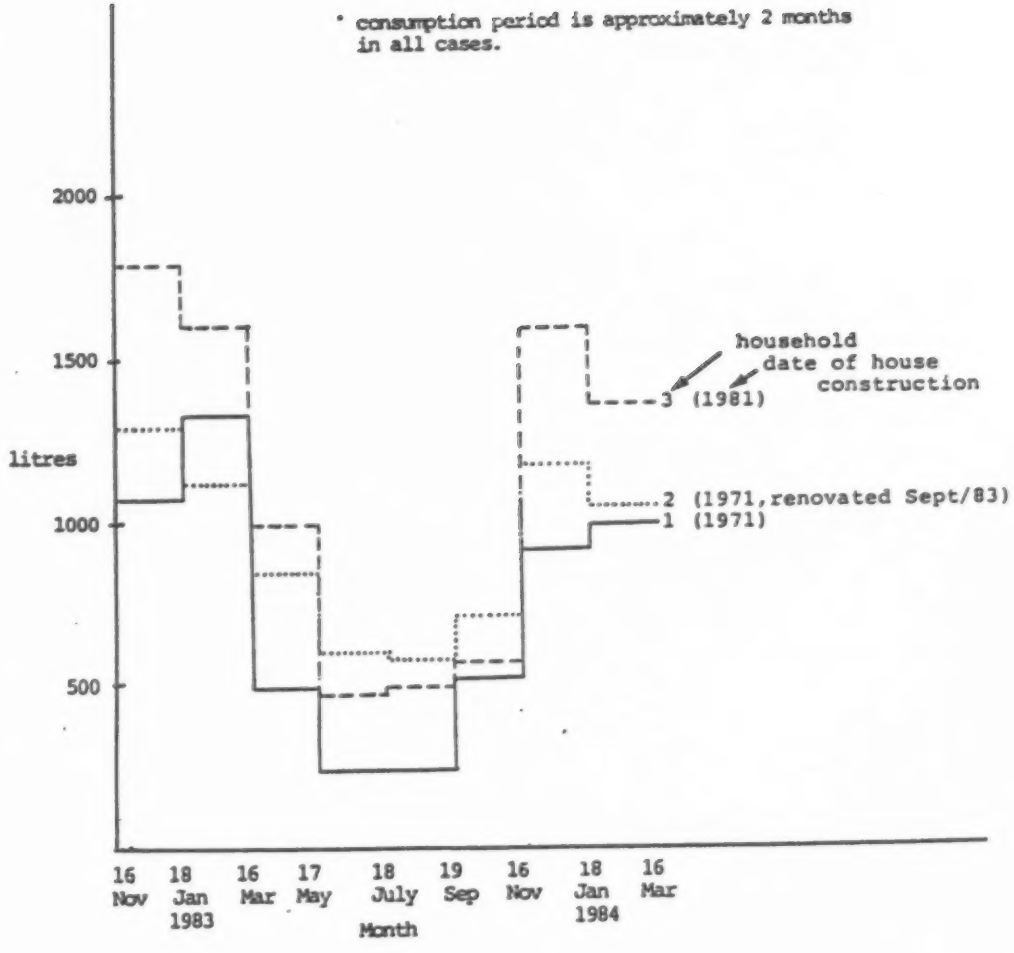


Figure 2-G(a) Total Oil Consumption for All Purposes for Three Households in Kangirsuk

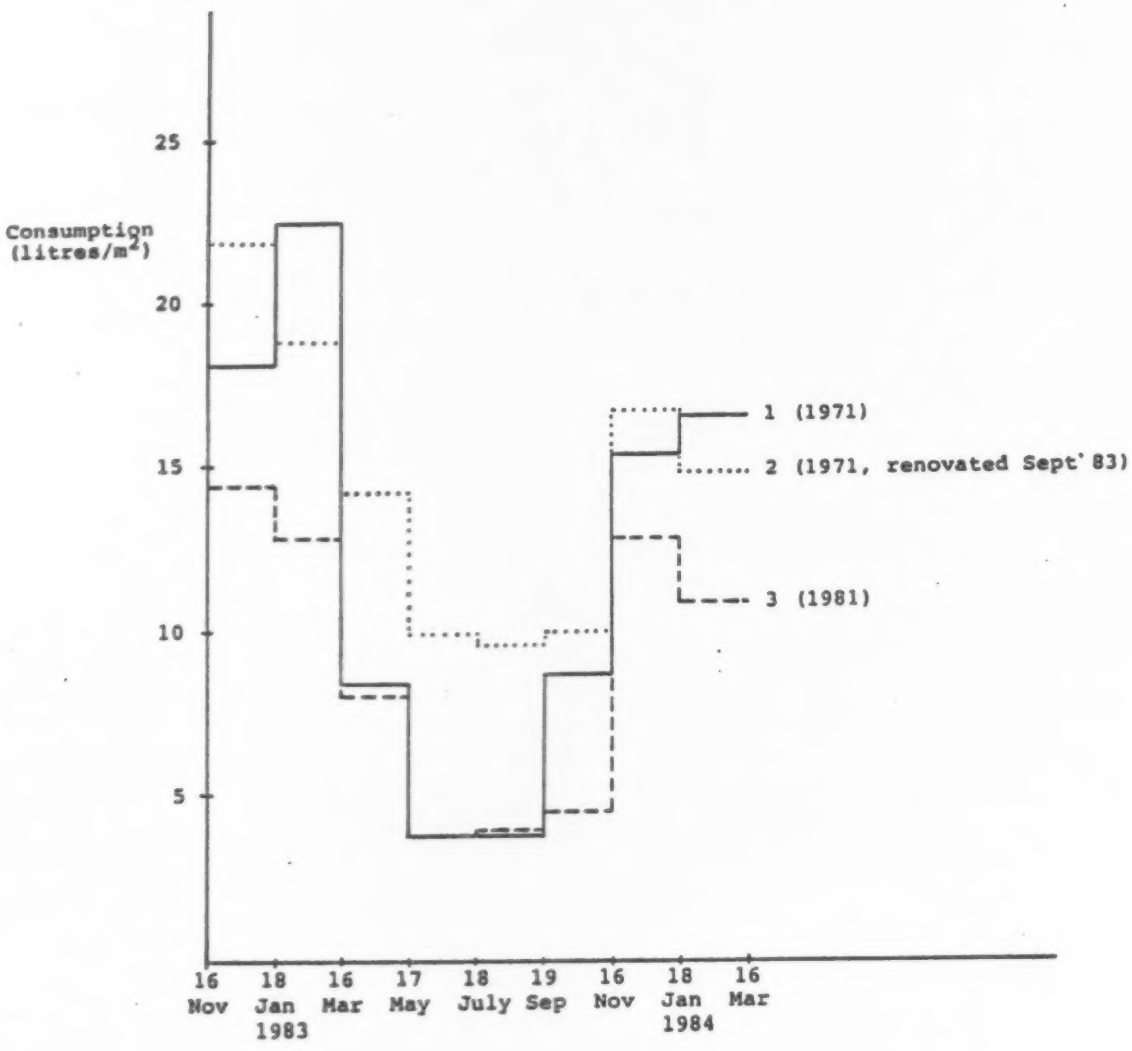


Figure 2-G(b) Oil Consumption for All Purposes Per Unit of Heated Floor Area for Three Households in Kangirsuk

the unrenovated house.

2.3.2 Electricity

Electricity consumption data for all SHQ households in Kangirsuk is presented in Tables 2-9 and 2-10 for the three year period ending in 1984. Table 2-9 gives the kWh consumed in each house and Table 2-10 lists the cost of this consumption for these same buildings. Included with the tables are the total annual consumption and cost figures for the buildings, the mean consumption and cost for the houses and the standard deviation of the data presented.

Since the consumption and cost data in Tables 2-9 and 2-10 are incomplete for the year 1984, an estimated consumption for the whole year has been calculated based on electricity consumption patterns in 1983. From the 1983 electricity consumption records, 10 houses were selected at random. Their totals for the first six months, or three billing periods, were compared with their total electricity consumption and cost figures for the year. The ratio of:

$$\frac{\text{total for the year}}{\text{total for the first 6 months}}$$

gives a multiplication factor which can be used to estimate the 1984 consumption and cost totals for all the SHQ housing.

The multiplication factors and projected 1984 annual total consumption and cost figures are given in Table 2-11.

The 1982 data for electricity cost is high since some of the household cost data contains arrears as far back as April 1981. All the arrears appear on the bills for the first two month period in 1982. To readjust the data to more accurately reflect the 1982 consumption, the mean bi-monthly cost data for the last ten months of 1982 for ten randomly selected houses was used as the data for the first two month period. The resulting projected total data of 1982 for the ten houses was then compared to the non-adjusted total for these same houses to obtain a correction factor for 1982 total cost data for all houses. The value of this correction factor was determined to be 0.70. The cost data recorded

Table 2-9 Electricity Consumption for SHQ Houses in Kangirsuk (kWh)

House #	1984***	1983	1982+	House #	1984***	1983	1982+
101	4990*	9840	5600**	128	12300	11790	4850
102	3450	6080	3160	129	2930	4220	4850
103	3790	6960	3910	130	--	--	--
104	2560	3740	3350	131	4220*	3520	2900
105	4000	--	2610	132	5680	11010	4630
106	3530	6530	3450	133	1590	3150	2920
107	3930	7910	5010	134	4320	7260	2860
108	3710*	5780	4450	135	9280	10800	8410
109	4750	7390	6930	136	5600	8340	5440
110	4220	7980	5150	137	10200	14340	3847
111	11300	7300	8000	138	2460	8110	3860
112	2470	5240	2970	139	10840	15370	8160
113	4250	3810	2360	140	3350*	5830	4060
114	3370	6690	4190	141	3540	6030	3760
115	4040	9410	5770	142	3440	7099	3480
116	3790*	6350	4930	143	4690*	6440	--
117	4350*	7960	4010	144	3830	7060	4760
118	5480	8000	4150	145	7510	12740	12350
119	9170	12570	8530	146	8570	12110	11310
120	4000	6520	5300	147	6580	11710	12560
121	2750	5610	3300	148	2710**		
122	6730	11440	--	149	2790**		
123	2140	2570	1820	150	2230**		
124	4380*	7400	4780	151	2270**		
125	3710	10070	7370	152	2430**		
126	3510*	6410	8130	153	2530**		
127	2890*	5620	2870	154	2820**		
				155	2340**		

	1984	1983	1982
Total:	188,310	352,109	227,107
n :	36	45	44
$\bar{x}$:	5231	7825	5162
s :	2846	3006	2556

NOTE: * Year incomplete; data not included

** One bill missing for that full year

*** 1984 data is for the first six months only

+ 1982 consumption data is incomplete since it contains data from five billing periods instead of six

Table 2-10(a) Electricity Cost for SHQ Houses in Kangirsuk (dollars)

House #	1984***	1983	1982+	House #	1984***	1983	1982+
101	619.17*	817.67	511.37**	128	1974.06	1113.77	443.50
102	229.63	399.38	294.69	129	170.77	262.77	417.36
103	211.71	407.54	334.62	130	--	--	--
104	133.60	216.11	304.84	131	468.74*	194.00	308.68
105	400.97	--	304.83	132	542.72	987.93	668.64
106	199.11	404.24	335.79	133	101.57	197.09	309.48
107	224.47	491.54	400.74	134	293.01	467.90	349.70
108	370.28*	286.17	370.76	135	1207.34	942.17	1020.00
109	368.03	509.92	602.91	136	529.93	566.91	412.36
110	276.00	522.71	392.24	137	591.12	855.33	249.20
111	1610.34	577.88	785.46	138	147.95	526.60	392.93
112	130.57	263.28	287.56	139	1503.84	1748.33	789.61
113	283.08	218.52	276.58	140	299.97*	358.46	414.29
114	175.43	372.04	368.89	141	168.80	329.52	318.62
115	247.57	717.63	545.30	142	249.55	444.30	426.68
116	384.95*	354.99	382.33	143	558.74*	381.52	--
117	492.19	602.84	494.53	144	203.04	420.11	793.00
118	508.39	595.23	370.01	145	890.80	1554.63	2475.46
119	1187.12	1255.36	1131.38	146	1092.31	1173.96	914.37
120	237.82	406.31	409.10	147	714.84	1103.93	1067.88
121	151.96	313.00	327.91	148	303.88**	--	--
122	737.86	1050.71	--	149	303.30**	--	--
123	120.02	178.50	246.79	150	191.79**	--	--
124	308.32*	516.96	405.74	151	209.41**	--	--
125	423.23	816.25	740.86	152	224.51**	--	--
126	332.50*	371.26	926.38	153	252.28**	--	--
127	211.70*	296.27	293.98	154	289.65**	--	--
				155	203.61**	--	--

	1984	1983	1982
Total:	18,241.56	26,503.54	23,617.35
n :	36	45	44
$\bar{x}$:	506.71	588.97	536.76
s :	475.80	365.44	382.12

Note: * Year incomplete; data not included
** February to May data only
*** 1984 data is for the first six months only
+ 1982 cost data includes arrears as far back as April, 1981

Table 2-10(b) Electricity Cost for SHQ Houses in Kangirsuk in 1981 Dollars

House #	1984	1983	1982
101	489.14	681.94	456.14
102	181.41	333.08	262.86
103	167.25	339.89	298.48
104	105.54	108.24	271.92
105	316.77	--	271.91
106	157.30	337.14	299.52
107	177.33	409.94	357.46
108	292.52	238.67	330.72
109	290.74	425.27	537.80
110	218.04	435.94	349.88
111	1272.17	481.95	700.63
112	101.15	219.58	256.50
113	223.63	182.25	246.71
114	138.59	310.28	329.05
115	195.58	598.50	486.41
116	304.11	296.06	341.04
117	388.83	502.77	441.12
118	401.63	496.42	330.05
119	937.82	1046.97	1009.19
120	187.88	338.86	364.92
121	120.05	261.04	292.50
122	582.91	876.29	--
123	94.82	148.87	220.14
124	243.57	431.14	361.92
125	334.35	680.75	660.85
126	262.68	309.63	826.33
127	167.24	247.09	262.23
128	1559.51	928.88	395.60
129	134.91	219.15	372.29
130	--	--	--
131	370.30	161.80	275.34
132	428.75	823.93	596.43
133	80.24	164.37	276.06
134	231.48	390.23	311.93
135	953.80	755.77	909.84
136	418.00	472.80	367.83
137	466.98	713.35	222.29
138	116.88	439.18	350.49
139	1188.03	1458.11	704.33
140	236.98	298.96	369.55
141	133.35	274.82	284.21
142	197.14	370.55	380.60
143	441.40	318.19	--
144	160.40	350.37	707.36
145	703.73	1296.56	2208.11
146	862.92	979.08	815.62
147	564.72	920.68	952.55
148	240.07	--	--
149	239.61	--	--
150	151.51	--	--
151	165.43	--	--
152	177.36	--	--
153	199.30	--	--
154	228.82	--	--
155	160.85	--	--
Total:	14,410.83	22,103.95	21,066.68
$\bar{x}$:	400.30	491.20	478.79

for the year 1982 was then multiplied by this correction factor to obtain a reasonable estimate for the actual 1982 cost data totals. From Table 2-10, the total cost for 1982 electricity consumption was given as $23,617.35. The readjusted total for 1982 is thus $23,617.35 x 0.70 = $16,532.15.

Similarly, the 1982 data for the quantity of electricty consumed had to be adjusted to compensate for the missing billing period data. An estimated consumption for the whole year has been calculated based on electricity consumption patterns in 1983. The correction factor derived from 1983 data was determined as follows:

$$\frac{\text{total consumption for the year}}{\text{consumption for five relevant billing periods}} = \frac{352{,}019 \text{ kWh}}{292{,}539 \text{ kWh}} = 1.20$$

Applying this correction factor to the recorded 1982 data gives a corrected 1982 total electricity consumption of:

$$227{,}107 \times 1.20 = 272{,}528 \text{ kWh}$$

In summary, the electricity consumption and cost information for Kangirsuk for the years 1982 through 1984 is given in Table 2-12.

Figures 2-H(a) and 2-H(b) are plots of the consumption and cost data of Table 2-12. Projections of cost increases are based on absolute consumption increases plus expected cost increases per unit of electricity.

From the data of Table 2-12 or the graph in Figure 2-H(a), it can be seen that the average rate of increase in quantity of household electricity consumed over the period 1982-1984 was 35%. During the same period the cost to the community for this electricity increased at an annual average of 68% in actual dollars spent or 58% in terms of 1981 dollars.

Table 2-11 Estimate of Projected Annual Electricity Consumption and Cost for 1984 in Kangirsuk

1983	Total for first six months (A)	Total for twelve months (B)	Multiplication factor (B/A)
kWh	35,336	67,450	1.91
cost	$2355	$4319	1.83

1984	Total for first six months	Multiplication factor	Projected Annual total
kWh	260,746*	1.91	498,025
cost	$25,287 **	1.83	$46,275

* based on 46 houses with average consumption of 5231 kWh per household for the first six months (see Table 2-9) and the eight new houses (units 148 through 155) with a total of 20,120 kWh in the first six month period.

** based on 46 houses with average electricity cost of $506.71 for first six months (see Table 2-10(a)) and the eight new houses (units 148 through 155) with a total cost of $1978.43 in the first six months of 1984.

Table 2-12 Summary of Tabulated and Estimated Consumption and Cost Data for Electricity Use in Kangirsuk

	1984	1983	1982
Consumption (MWh)	498.0	352.1	272.5
Cost (x 1,000 $)	46.3	26.5	16.5
Cost in 1981 $ (x 1,000 $)	36.6	22.1	14.7

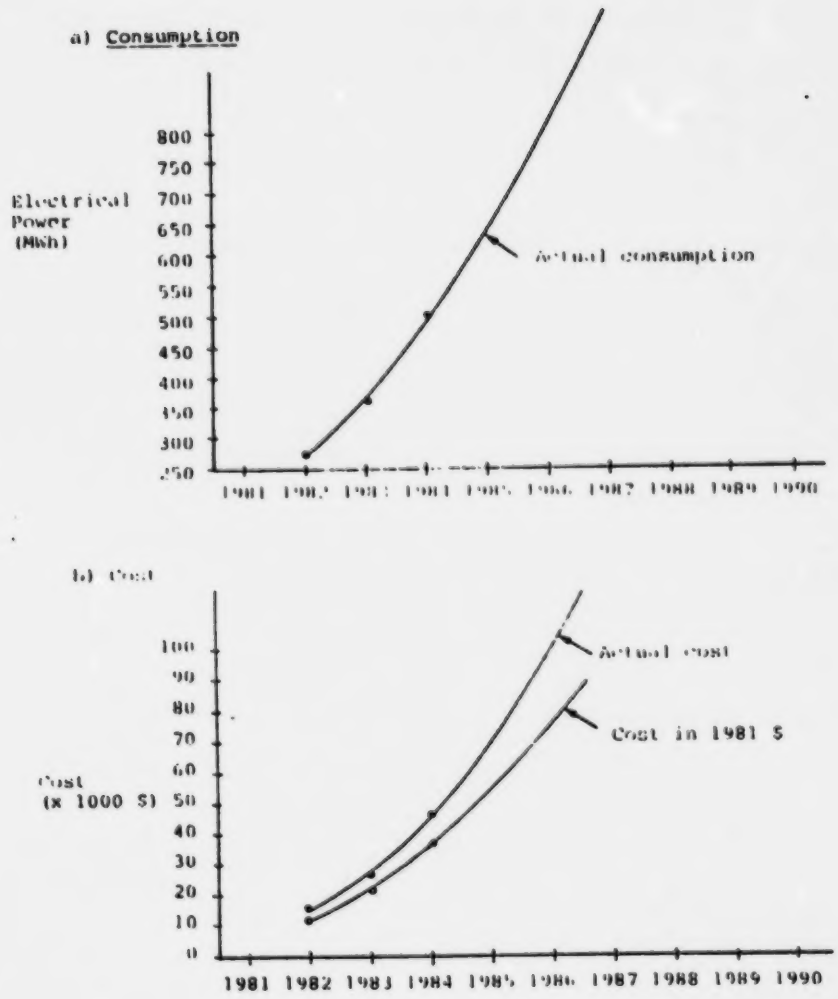


Figure 2-H Electricity Consumption and Cost - Kangirsuk

Sample Household Electricity Consumption Patterns: The same three SHQ housing units that were selected for sample fossil fuel consumption patterns were also selected for graphically plotting electricity consumption. The total electricity consumption, in kWh, for all purposes in each of the three households has been plotted on a bi-monthly basis over an 18-month time span ending in May, 1984. (See Figure 2-I) All data is from Hydro-Quebec bills maintained for each of the households at the Council of the Northern Village of Kangirsuk. Data reflects the billing period; therefore each two-month period does not represent exactly the same number of days.

In selecting these houses, no attempt was made to find households with similar occupancy and electricity use patterns, thus no rigorous comparisons can be drawn from the data presented. It is interesting to note, however, that the electricity consumption in all three households tends to peak in mid winter. Also, the occupants of the newer house (#3) tend to consume significantly more electrical power than those living in the smaller houses. Households #1 and #2 had more or less equivalent electricity consumption before house #2 was renovated. Once renovated, house #2 used consistently more electrical power than house #1, a result, in all probability, of increased electrical applicances and services in the renovated house. Based on unit floor area, houses #1 and #2 maintain this same relationship throughout. On the other hand, house #3, the larger new house, does not generally follow the bi-monthly extremes of the other two houses.

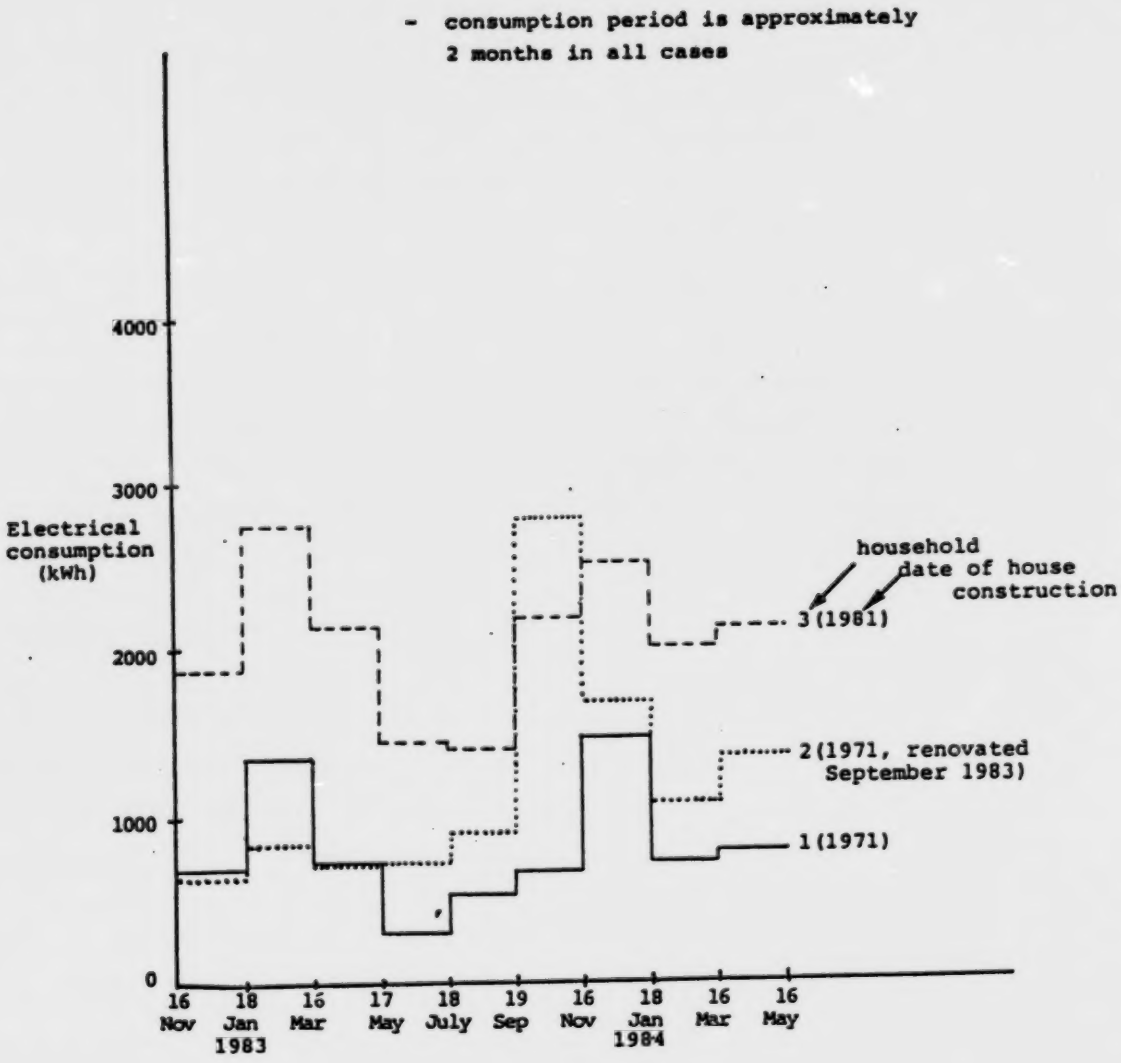


Figure 2-I(a) Electricity Consumption for All Purposes for Three Households in Kangirsuk

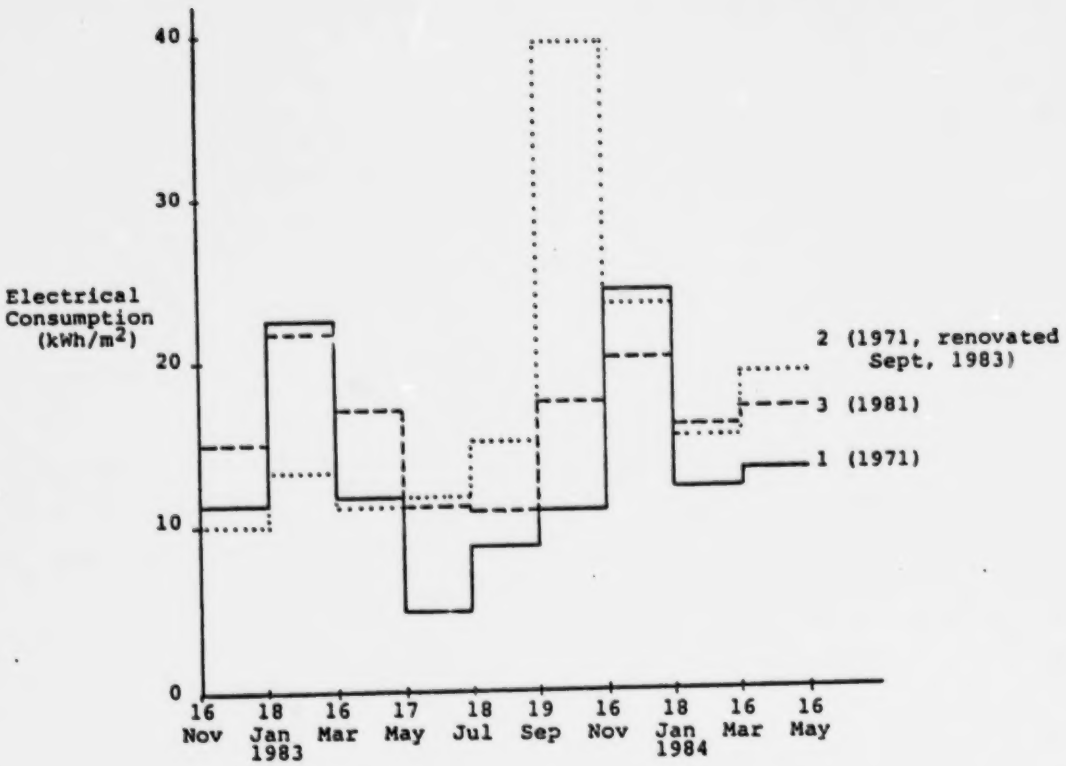


Figure 2-I(b) Electricity Consumption for All Purposes per Unit of Heated Floor Area for Three Households in Kangirsuk

2.4 Hydro-Electric Potential for Kangirsuk

Three sites near Kangirsuk were identified by Hydro-Quebec as potentially capable of supplying Kangirsuk's electrical energy demand in the year 1990.

Site 1 - on the Buet River, 7 km from its mouth
Site 2 - on a tributary of the Buet River which enters the Buet 6.5 km from its mouth, 20 km from Kangirsuk
Site 3 - 3 km to the east of Kangirsuk

Site 1 was rejected because of the immensity of the dam required and the difficulties with site preparation. Site 3 was rejected due to poor ground quality (silty moraine) and due to the fact that the river flow was insufficient. Site 2 was selected for further investigation due to favourable topographic considerations and a solid rock base in the area of the potential dam and reservoir.

Site 2 description:

drainage basin	-	176 km^2 upstream of the site
average river flow	-	2.4 m^3/sec
minimum river flow	-	less than 1 m^3/sec during winter (assumed 0 flow from December to June)
maximum river flow	-	7.7 m^3/sec in July
hydraulic head	-	75.5 m
reservoir capacity	-	sufficient to allow generation during December and January
turbine	-	cross-flow, 910 kW nominal power
project cost	-	$10,217,500 in 1982 dollars
cost/kW	-	$11,228

Projected electrical energy demand for the year 1990 and estimated output of the proposed site 2 are given in Table 2-13. Hydro-Quebec concluded that even though this site offered a number of favourable

natural characteristics, the cost of exploiting the resource is prohibitive given the limited energy demands of the community.

Table 2-13 Projected Electrical Energy Demand and Estimated Production from Hydro-Site 2 for the Year 1990

Month	Energy Demand (GWh)	Energy Produced (GWh)
October	0.32	0.32
November	0.35	0.35
December	0.46	0.46*
January	0.50	0.50*
February	0.44	**
March	0.42	**
April	0.35	**
May	0.27	**
June	0.23	0.23
July	0.18	0.18
August	0.20	0.20
September	0.24	0.24
Total	3.96	2.45 (65% of demand)

* A small reservoir permits generation during December and January.

** Assumed that there is no water flow in the river from December to June

Source: (1) Petites Centrales Peninsule D'Ungava: Evaluation Sommaire. Hydro-Quebec, Direction Ingeniere de Centrales, Vice-Presidence Ingeniere et Construction, Montreal. March, 1983.

3.0 DATA RELEVANT TO KUUJJUAQ

3.1 Background Data

3.1.1 General Information

The Northern Village of Kuujjuaq is located on the western bank of the Koksoak River 51 km from Ungava Bay. (See Figure 3-A.) It plays the role of administrative center and hub of activities for the Ungava Region. In addition to being the base of operations for regional, provincial and federal government agencies, the only hospital in the area is located there. Air Inuit is also based in Kuujjuaq. Languages spoken are Inuktituk, English and French.

Location

Latitude : 58°05' N
Longitude : 68°24' W

Population: 894 Inuit (1982) Households: 219 families (1983)

Transportation

Air: The community is directly linked to Southern Quebec via regular flights provided by Nordair, 4-6 times per week depending upon the season. Kuujjuaq is the base for Air Inuit, a subsidiary of the Makivik Corporation and it offers a regular service to Ungava Bay, Hudson Strait and Hudson Bay communities.

Road: There are approximately 10 km of community streets

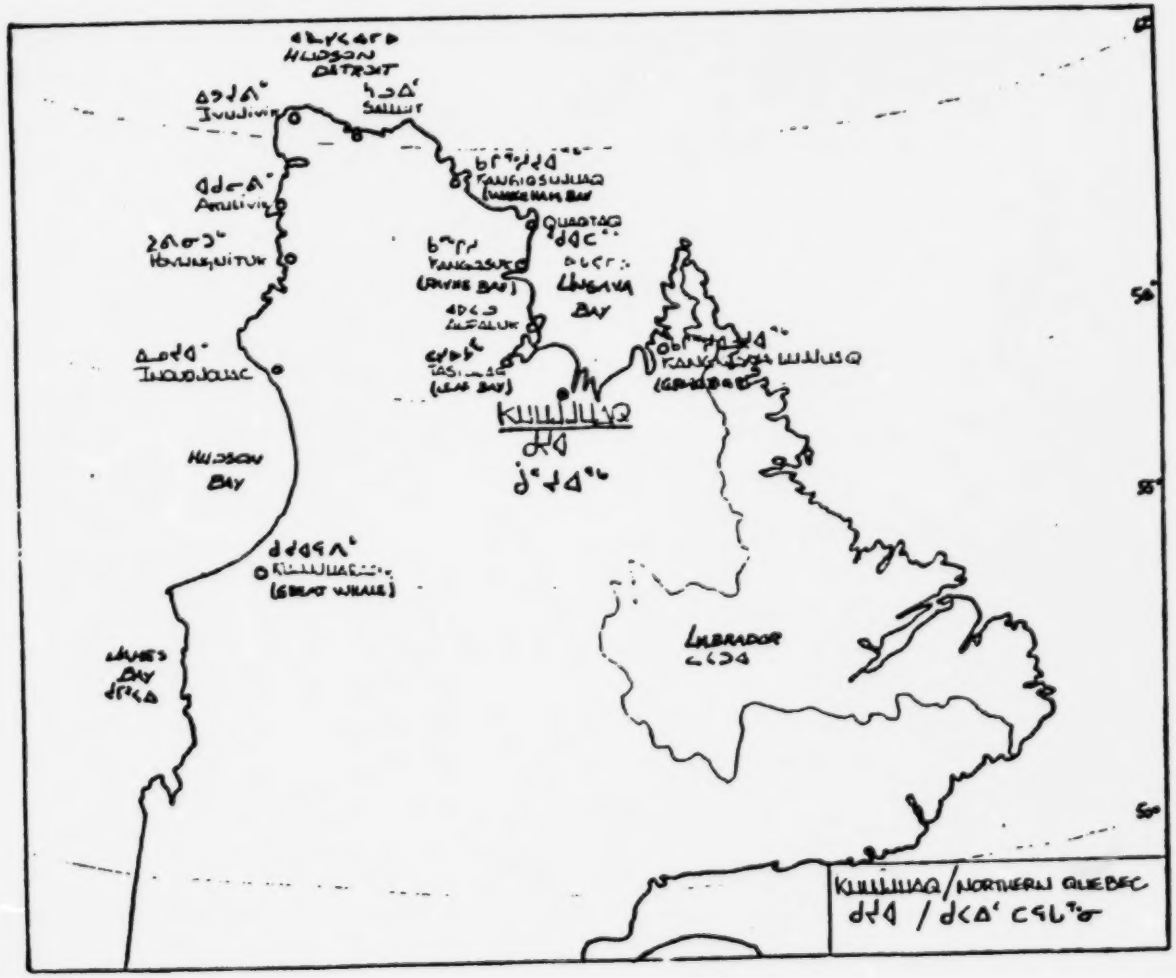


Figure 3-A Location Plan for Kuujjuaq

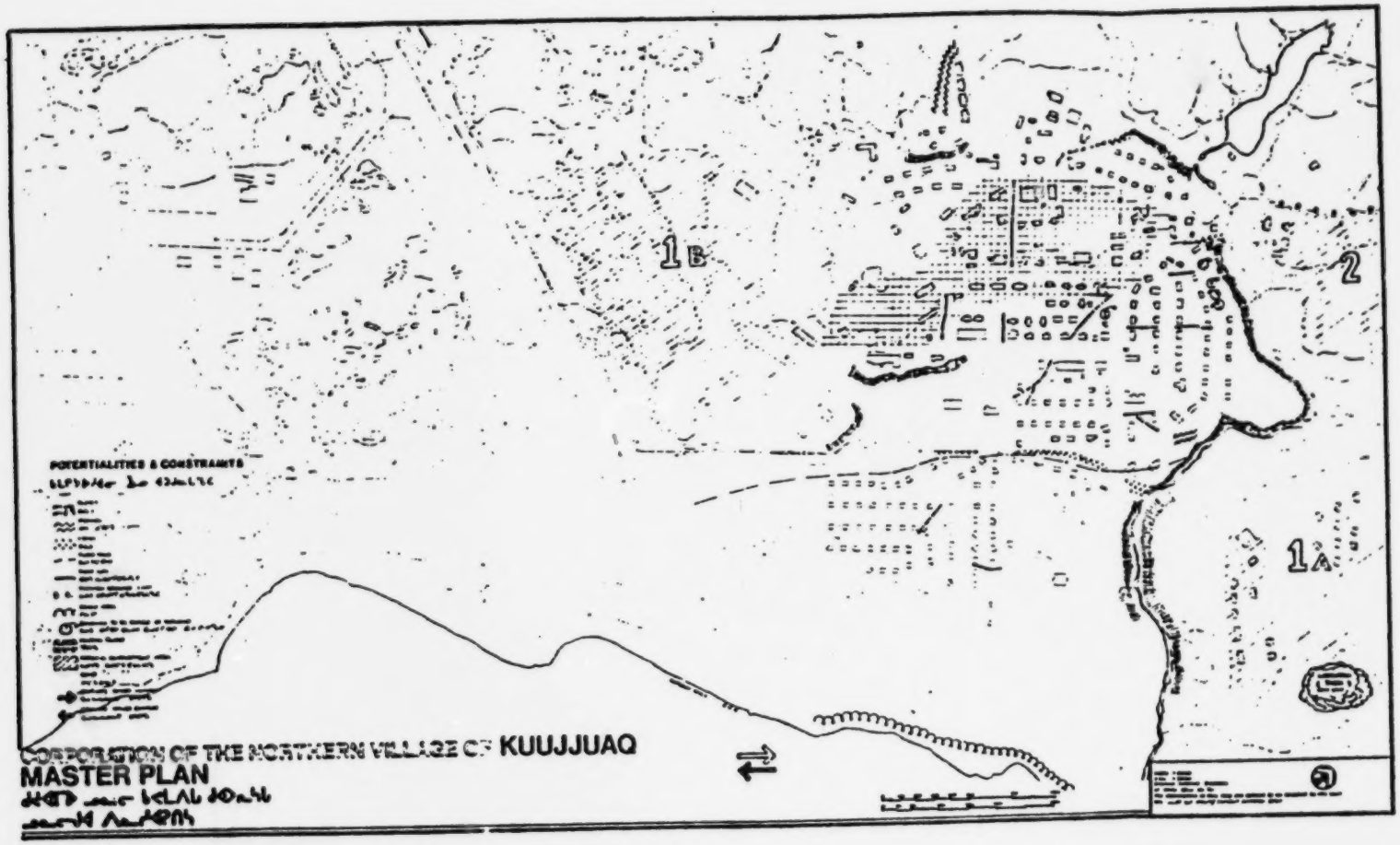


Figure 3-B Master Plan for Kuujjuaq

Climate

The climate of Kuujjuaq is typical of sub-artic regions: long, cold, dry winters and short, cool and humid summers.

Table 3-1 Climatic Data for Kuujjuaq

Avg. Yearly Temperature	:	- 5.5°C
Avg. Temperature, Jan.	:	-23.3°C
Mean Daily Max., Jan.	:	-18.8°C
Mean Daily Min., Jan.	:	-27.8°C
Avg. Temp., July	:	11.4°C
Mean Daily Max., July	:	16.9°C
Mean Daily Min., July	:	5.8°C
Frost Free Days	:	60
Total Precipitation	:	476 mm - 40% is snow
Depth of Permafrost	:	100+ m
Active Permafrost Layer	:	0.3 - 0.72 m

3.1.2 Population Trends

Historical and future population trends are presented in Table 3-2. Data for this table were taken from the Corporation of the Northern Village of Kuujjuaq -- Master Plan, July 1981. Figure 3-C, obtained from the same source, illustrates the age and gender breakdown of the Inuit community in 1979.

Table 3-2 Population Statistics and Forecasts for Kuujjuaq

Year	Inuit Pop.	# Families	Total Pop.**
1969	514	91	
1971	516	93	
1973	517	99	
1975	572	105	
1977	739	144	
1979	818	192	1,068
*1980	842	200	1,100
*1981	867	206	1,133
*1982	893	212	1,167
*1983	920	219	1,202
*1984	958	225	1,238
*1985	976	232	1,275
*1986	1,005	240	1,313
*1987	1,035	265	1,392
*1988	1,066	290	1,392
*1989	1,098	316	1,434
*1990	1,131	343	1,477
*1991	1,165	371	1,522

NOTE: * Represents projected figures based on an annual growth rate of 3% which represents an average between 5.4% for Northern Quebec and 1.4% for Kuujjuaq.

** Includes non-Inuit members of the community.

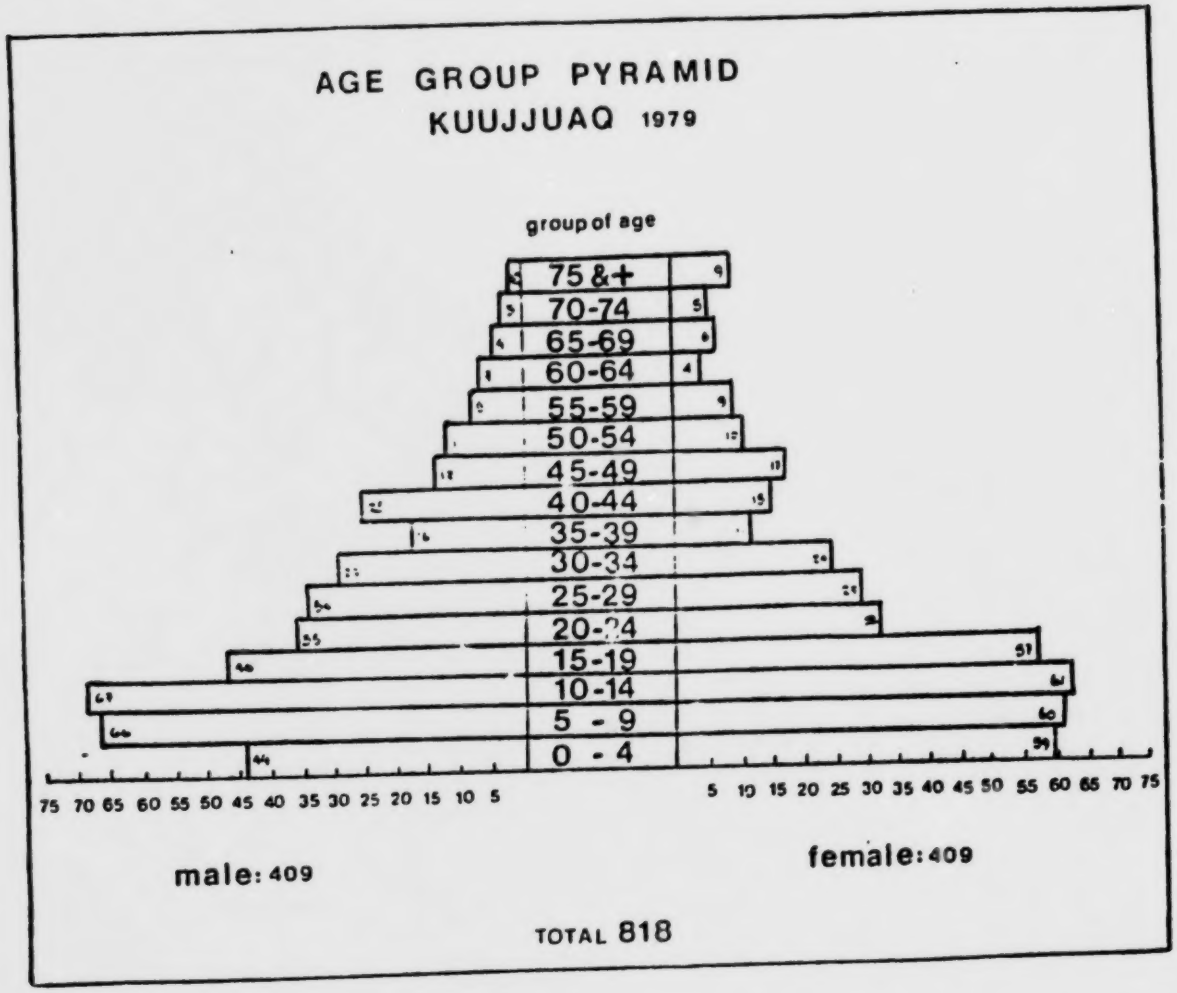


Figure 3-C Age Group Pyramid, Kuujjuaq, 1979

3.1.3 Community Buildings

The number of buildings in the community and their functions is given in Table 3.3. Table 3-4 lists the number of new and renovated housing starts by SHQ since 1980.

Table 3-3 Kuujjuaq: Distribution of Buildings by Function

Function	Total
Residential	264
Commercial	9
Industrial & Warehouse	42
Offices	10
Public Services	25
Others	13
	363

Source: Data for this chart has been taken from the Corporation of the Northern Village of Kuujjuaq - Master Plan, July, 1981. The number of residential units has been updated from 232 to 264 from data obtained in 1984 from Jim Walsh, Housing Manager of the Northern Village of Kuujjuaq.

Table 3-4 New and Renovated Housing Starts by SHQ -- Kuujjuaq

	1980	1981	1982	1983	1984
new	-0-	6	6	-0-	14
renovated	-0-	2	11	-0-	26

3.2 Energy Supply

3.2.1. Fossil Fuels

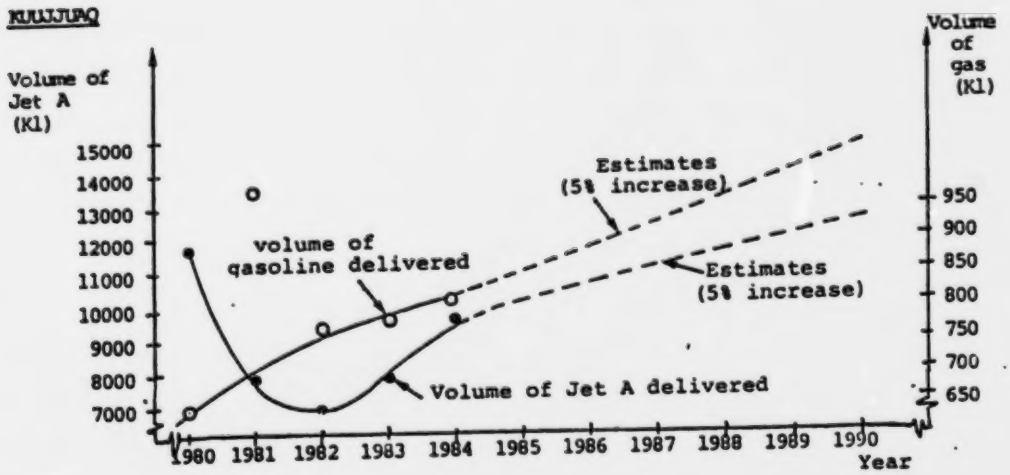
The major energy supplier to Kuujjuaq is Shell Canada. Shell Jet A-1 is used as furnace oil and regular leaded gasoline supplies transportation needs. In addition, Shell aviation gasoline 100 is periodically delivered to fuel airplanes operating out of Kuujjuaq. Figure 3-D presents the actual volume of furnace oil and gasoline delivered to Kuujjuaq from 1980 to 1984. Shell Canada's estimate of 5% annual increase in the sales of both fuels is also presented as the best estimate of projected supply through the year 1990. Aviation gas deliveries to Kuujjuaq during this same period were 789,000 litres in 1981 and 954,000 litres in 1984.

Some propane and other bottled gas is available in Kuujjuaq. However, no records were found of the quantities coming into the community since it is generally individuals who order the fuels in this form directly from southern suppliers. In any event, the quantities are minute compared to the other fossil fuels. It is known that two SHQ houses and six KRG houses currently use propane gas for cooking. Each house is supplied with approximately two 100 pound cylinders per year. It is anticipated that these gas cookstoves will be replaced by electric stoves in 1985.

Camping gas supplies, in the form of small pressurized cylinders are sold at The Bay and the Cooperative, but again, the total supply is minuscule compared with supplies of other fossil fuels.

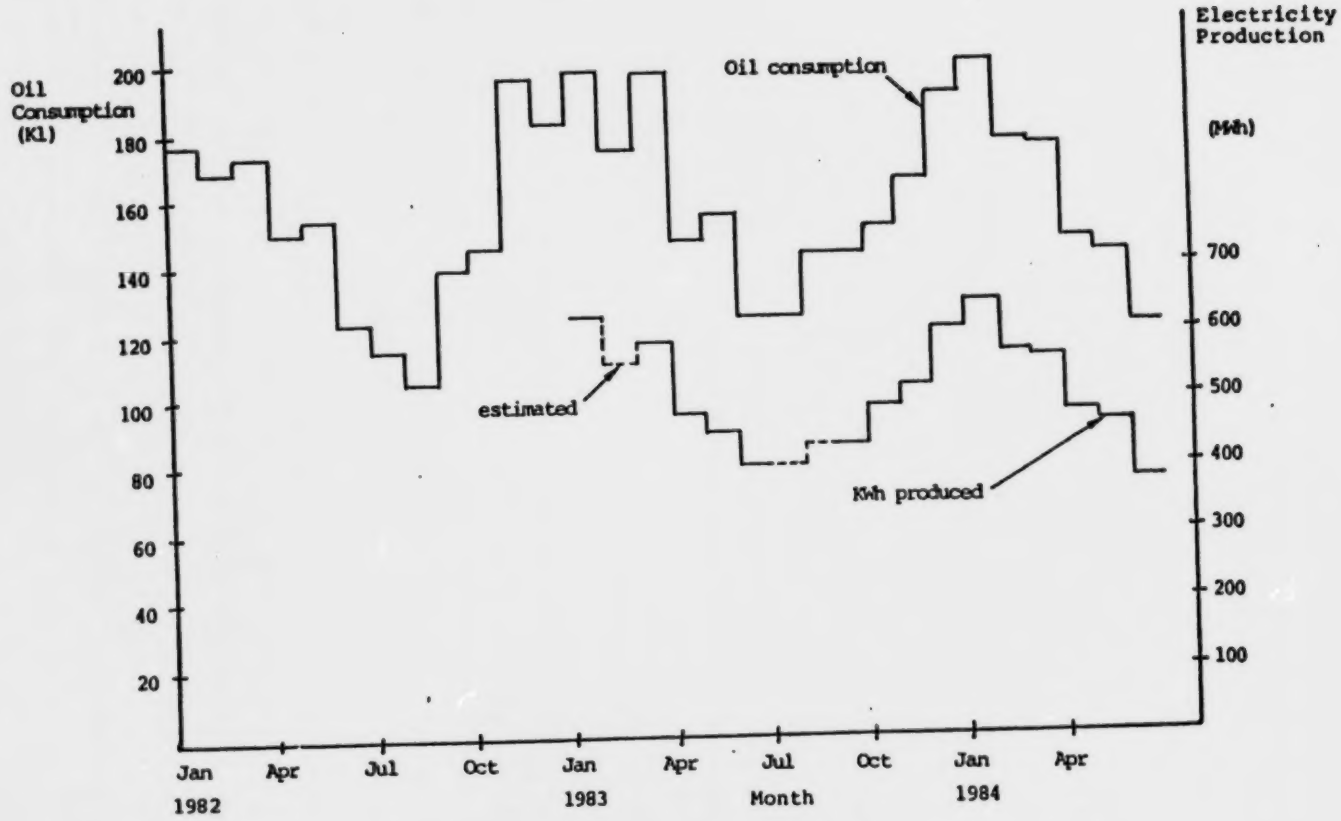
3.2.2 Electricity

Although a derived energy form since it is based on the use of Jet A-1, electricity supplied to the community is given in Figure 3-E. Data is presented as kWh produced by the HQ generators on a monthly basis for the 18-month period ending in March 1984. Oil consumption to produce this electricity is shown on the same figure. The best estimate of anticipated electricity production is that it will keep pace with consumption, which for SHQ houses in Kuujjuaq has increased at an annual



Source: Letter from Shell Canada, 27 July, 1984.
See Appendix A

Figure 3-D Fossil Fuel Supplies to Kuujjuaq,1980 to 1990



Source: Hydro-Quebec monthly production reports for Kuujjuaq

Figure 3-E Monthly Oil Consumption and Electricity Production at Kuujjuaq's Hydro-Quebec Generating Station

average rate of 10% from 1982 to 1984.

3.3 Energy Consumption

Energy consumption data presented here for Kuujjuaq includes the use of furnace oil in SHQ housing from 1981 to 1984 and electricity in SHQ housing from 1982 to 1984. Both quantities of energy consumed and cost data are given. Fuel consumption for municipality-owned vehicles is presented for the years 1981 through 1983 and some indicator of the quanitiy of propane gas used in the community for cooking is also given. The reasons for not including other data are similar to those given for Kangirsuk in Section 2.3. SHQ housing in Kuujjuaq represents about 55% of the total housing stock thus the information given is fairly representative of the gross community energy consumption pattern.

Nevertheless, it is recognized that the total energy consumption picture is incomplete and effort should be expended at some future time to attempt to fill the information gap.

3.3.1 Fossil Fuels

Fossil fuel consumption data is presented for heating oil used in SHQ houses. Table 3-5 gives individual house consumption records for four years. Included in the table are the total heating oil consumption for each year, the mean oil consumption for all houses and the standard deviation of data presented about the mean.

Heating (furnace) oil consumption in Table 3-5 is incomplete for 1984 since it contains data only for the first six months of the year. In order to estimate the full year's consumption we have assumped a similar pattern of monthly usage as the average consumption pattern for the years 1981 through 1983. The multiplication factor determined from this is 1.54 for all houses in the data population. This multiplication factor was then used to estimate total 1984 heating oil consumption as follows:

$$\text{total consumption for 1984} = \text{total of first six months} \times 1.54$$
$$= 425{,}143 \times 1.54$$

= 654,483 litres

Total yearly consumption of heating oil in the SHQ houses is resumed for the years 1981 through 1984 in Table 3-7 and plotted in Figure 3-F(a). Consumption normalized to the heated floor area and heating degree days, is plotted in the same figure.

Costs for this domestic fuel oil consumption are listed in Tabble 3-6, summarized on a yearly basis in Table 3-7 and plotted in Figure 3-F(b). To estimate the total 1984 fuel oil cost, the average 1984 unit price with prepaid discount from Shell Canada information was applied to the estimated total 1984 consumption. Thus:

1984 cost total = 654,483 litres x $0.5123/litres
= $335,292

The four years of furnace oil consumption and cost data presented allow some projections to be made concerning future fuel use. A low growth estimate has been made based on increases in past consumption and cost, excluding the 1982 data. This projected future growth is somewhat above Shell Canada's estimated 5% and 8.5% per annum increases in volume and cost respectively. The high gr th projection assumes that the 1982 data was not entirely an anomoly. For lack of any further information, the high growth projection in volume was assumed to be 10% per year greater than the low growth projection and in cost the corresponding increase was 12% per annum to reflect the faster rise in actual costs than in volume of consumption.

Normalized volumes of consumption and cost both increase in contrast to the same curves for Kangirsuk which show a gradual decline. A possible reason is that, to date the quantity of renovated and new houses is still insignificant compared to the existing stock which is fast deterioriating in thermal performance.

Table 3-5 Heating Oil Consumption for SHQ Houses in Kuujjuaq (in litres)

House #	1984	1983	1982	1981
23	1574	3956	5367	3031
24	2167	6201	5606	2874
25	2449	4222	5467	3843
26	2477	4256	4787	3262
27	2067	6037	4943	2308
28	--	--	6279	--
75	2259	5321	--	4058
90	2601	3501	3710	3056
100	2458	3588	2987	3065
105	1711	3003	3966	2192
106	3561	4309	6111	3197
107	--	--	--	2907
110	4238	4933	6071	3439
111	4698	6515	8110	5516
118	3224	4124	5119	3295
119	2356	6911	4758	2994
120	4654	4730	6922	4113
121	3032	4193	5646	3314
122	3355	5227	4866	3471
123	3320	4446	5613	4143
124	1926	3631	8555	4344
125	4827	5876	6084	4693
126	1281	3260	3262	2254
127	3227	3575	4797	2835
128	2509	3822	4879	2455
129	3162	3818	4728	3022
130	3394	4589	5772	3018
131	3487	3858	5744	3869
132	3211	4283	1185	4296
133	3564	5086	5637	--
134	3977	4342	5482	3054
135	3648	4055	5683	3856
136	3029	2790	4452	2649
137	3199	3738	4695	3216
138	2790	3244	4510	2608
139	3233	4235	5821	3462
140	2898	3648	4955	2763
141	3062	4276	4948	3045
142	3253	4646	5099	3612
143	4138	5661	5179	2942
144	1759	2759	4436	2578
145	3412	4915	5235	3857
146	3599	5300	5091	4302
147	3039	4381	4771	3102
148	3640	2402	5695	4172
149	2994	3949	3856	3245
150	3962	2915	4355	2780
151	2163	3018	4480	2810
152	3051	4704	6115	3762
153	3545	4857	4592	3553
154	3106	--	5140	3124
155	2636	3646	4309	3108
156	3255	4309	5217	3021
157	5739	6153	8834	3450

Table 3-5 (Continued)

House #	1984	1983	1982	1981
158	2881	4049	4160	2691
159	2756	3151	4347	3843
160	3408	4117	6434	3244
161	3221	3276	3739	2609
162	4607	4889	6545	4212
163	3190	4653	5578	3550
164	2032	3329	3757	1952
165	3336	4051	4718	3435
166	2458	4206	4629	2669
167	3549	6659	5592	3834
168	2086	3064	3416	2047
169	3706	4800	5260	3321
170	2532	2992	4338	3166
171	1696	3967	5623	4132
172	2125	4450	5152	3968
173	2352	5142	6079	3837
174	2181	3451	3923	3511
175	1783	6455	6044	4105
176	3872	6264	6376	4914
177	2110	3333	3961	2592
178	2341	4788	7001	3491
179	1509	4556	4175	3709
180	2200	3168	4452	2869
181	1817	3020	3476	2726
182	2218	3926	4099	2727
183	1892	2341	652*	3796
184	1600	3432	2588	2257
185	2562	3654	5087	3205
186	2118	4498	6382	3943
187	1065	2217	2014	640
188	4220	4818	5353	2460
189	3913	5777	6649	4463
190	3888	4659	7692	3745
191	3428	--	5555	3251
192	3365	5030	7283	2618
193	2130	2573	6213	3016
194	2326	3087	6165	3094
195	3294	4958	5187	4223
196	3435	5920	6633	4359
197	4182	5679	5915	3928
198	4352	--	4588	3398
199	2308	4122	5270	3199
200	2355	4281	4531	3161
201	2694	4555	6537	4052
202	2288	4033	4325	2748
203	2243	3675	5073	2965
204	2085	5566	4988	3301
205	3585	3860	5811	3541
206	2520	5891	5051	3173
207	3328	4017	5233	3248
208	2048	3538	464*	2926
209	3851	5136	5660	3651
210	2856	3367	4684	2624
211	2753	4651	6835	4166
212	3596	6637	9388	3603

Table 3-5 (Continued)

House #	1984	1983	1982	1981
213	2584	5675	471*	2898
214	3113	4088	3823	3392
215	3154	5393	5653	3051
216	4572	5275	5694	3302
217	3203	3670	6323	3862
218	4009	5176	6175	4250
219	3710	4139	4649	2717
220	3671	6249	8074	3852
221	2464	4796	5493	2722
222	2918	4983	6743	4289
223	5921	6616	11437	5324
225	1740	2969	3521	4022
226	1554	3041	3830	1333
227	4239	8473	7159	4117
228	3468	4410	6825	2807
229	3185	5219	5434	2489
230	2661	2283	6164	6584
231	2658	3708	4947	2003
232	5029	6036	8453	3691
233	--	--	--	--
234	2282	3294	4844	4261
235	1982	2374	3749	2285
236-A	3573	5014	4105	--
236-B	3551	5706	5465	--
237-A	4301	4854	4831	--
237-B	4041	3851	4318	--
238-A	4662	5952	4740	--
238-B	3603	--	4673	--
239-A	--	3189	613*	--
239-B	3916	4804	814*	--
240-A	4093	5423	594*	--
240-B	3336	4609	714*	--
241-A	3477	3751	799*	--
241-B	4041	4553	801*	--
TOTAL:	425,143	598,515	697,207	428,094
n :	139	136	131	128
$\bar{x}$:	3058	4401	5322	3344
s :	903	1121	1381	788

* Year incomplete; data not included.

Table 3-6(a) Furnace Oil Consumption cost in Dollars for SHQ Houses in Kuujjuaq

House #	1984	1983	1982	1981
23		1902.58	2951.30	1240.81
24		2978.19	2688.82	1180.73
25		2043.78	2397.91	1551.11
26		2059.67	2090.39	1314.27
27		1899.96	1839.58	1318.58
28		--	2755.44	--
76		2086.66	--	1685.29
90		1692.59	1686.38	1275.14
100		1723.02	2386.48	1271.95
105		1292.89	1737.94	892.87
106		2085.10	2984.74	1347.51
107		--	--	1174.45
110		2374.22	2667.10	1368.70
111		3147.15	3554.28	2194.11
118		1992.34	2268.30	1345.33
119		1758.95	2088.96	1210.81
120		2276.74	3033.89	1723.79
121		2026.00	2473.06	1363.46
122		2542.37	2148.28	1431.69
123		2147.77	2451.92	1692.13
124		1734.59	3772.91	1783.24
125		2800.71	2155.20	1923.53
126		1586.89	1418.68	903.36
127		1711.18	2110.64	1106.68
128		1362.11	2133.84	984.54
129		1850.22	2098.31	1222.48
130		2215.64	2557.16	1232.31
131		1866.82	2530.78	1563.63
132		2069.83	564.65	1775.79
133		2100.05	2493.99	--
134		2097.45	2412.15	1239.22
135		1958.50	2505.54	1587.23
136		1338.71	1959.68	1079.25
137		1807.58	2064.34	1322.57
138		1562.60	1985.32	1051.11
139		2042.89	2470.48	1387.60
140		1760.93	2183.21	1150.59
141		2065.41	2156.08	1304.88
142		2244.72	2223.78	1481.69
143		2732.86	2265.55	1197.95
144		1325.95	1954.43	1041.14
145		2369.76	2275.68	1567.72
146		2556.83	2217.60	1772.07
147		2112.64	2064.25	1261.71
148		1180.85	2459.99	1696.83
149		1907.16	1693.42	1327.50
150		1416.20	1918.44	1127.09
151		1453.80	1950.71	1148.93
152		2270.20	2690.03	1535.08

Table 3-6(a) (Continued)

House #	1984	1983	1982	1981
153		2340.15	1999.28	1450.00
154		--	2256.55	1266.95
155		1757.65	1871.09	1262.08
156		2083.78	2297.24	1225.83
157		3346.75	3861.86	1455.58
158		1959.35	1835.74	1089.59
159		1522.26	1906.93	1543.88
160		1995.61	2791.62	1330.42
161		1582.07	1648.13	1060.22
162		2363.15	2896.46	1712.69
163		2254.05	2450.63	1461.79
164		1848.07	1645.73	778.27
165		1956.80	2089.46	1415.43
166		2028.75	2035.52	1080.38
167		1893.26	2459.94	1572.08
168		1476.89	1499.08	818.00
169		2322.96	2295.95	1318.98
170		1450.04	1910.18	1318.44
171		1909.96	2454.00	1616.59
172		2137.83	2205.83	1624.40
173		2490.78	2069.23	1579.53
174		1671.95	1715.09	1405.45
175		3093.62	2625.09	1692.90
176		3046.26	2760.03	2024.50
177		1618.62	1750.21	1055.92
178		2319.66	3116.74	1778.72
179		2208.41	1783.64	1536.09
180		1516.38	1953.59	1187.54
181		1462.29	1509.00	1174.25
182		1888.64	1752.57	1132.88
183		1134.13	310.68*	1523.44
184		1665.85	1145.00	914.11
185		1762.34	2231.69	1308.48
186		2169.98	2810.43	1587.64
187		1071.56	870.45	258.98
188		2334.46	2369.63	1006.05
189		3029.64	2935.63	1854.03
190		2236.58	3380.31	1513.92
191		--	2403.31	1320.70
192		2431.82	3208.69	1047.73
193		1241.52	2753.83	1267.54
194		1490.82	2734.52	1260.59
195		2394.39	2262.41	1704.13
196		2772.20	2891.60	1786.28
197		2744.41	2580.55	1605.08
198		--	1998.83	1392.48
199		1993.67	2316.55	1300.06
200		2062.24	1983.48	1291.38
201		2518.71	2893.40	1650.85
202		1903.08	1891.54	1114.84
203		1777.26	2186.11	1200.34
204		1851.43	2182.94	1338.41
205		1874.43	2563.69	1381.41

Table 3-6(a) (Continued)

House #	1984	1983	1982	1981
206		1883.02	2213.13	1278.25
207		1942.60	2397.48	1324.36
208		1694.19	221.09*	1230.74
209		2482.26	2497.15	1494.82
210		1627.13	2062.15	1068.28
211		2265.83	2995.11	1713.73
212		3211.65	4097.82	1823.67
213		2742.51	244.43*	1156.60
214		1968.29	1639.71	1372.22
215		2598.14	2457.23	1475.55
216		2552.36	2518.70	1369.89
217		1772.86	2778.94	1581.59
218		2490.03	2504.34	1578.94
219		2003.30	2051.50	1734.32
220		2917.23	3566.20	1103.52
221		2319.88	2400.15	1097.40
222		2393.56	3138.34	1780.82
223		3180.72	5003.14	2132.74
225		1441.57	1544.36	1637.12
226		1467.45	1646.36	555.66
227		2660.37	3172.62	1670.66
228		2130.75	2976.42	1018.66
229		2124.74	2293.35	1148.68
230		1110.22	2653.34	2527.30
231		1791.76	2118.64	842.21
232		2917.95	3714.01	1505.84
234		1591.95	2119.73	1724.78
235		1147.96	1635.56	899.72
236-A		2422.92	1831.11	--
236-B		2758.97	2357.63	--
237-A		2337.10	2158.59	--
237-B		1853.72	2207.13	--
238-A		2879.76	2157.24	--
238-B		1816.55	2065.98	--
239-A		1519.54	292.09*	--
239-B		2318.68	387.87*	--
240-A		2610.18	283.04*	--
240-B		2220.62	340.22*	--
241-A		1804.96	380.72*	--
241-B		2194.42	381.67*	--
Total:		282,707.27	307,203.76	175,803.37
n :		137	131	128
$\bar{x}$:		2063.56	2345.07	1373.46
s :		491.55	606.58	319.36

* Year incomplete; data not included.

Table 3-6(b) Furnace Oil Consumption Cost in 1981 Dollars for SHQ Houses in Kuujjuaq

House #	1983	1982	1981
23	1586.75	2632.56	1240.81
24	2483.81	2398.43	1180.73
25	1823.05	2138.94	1551.11
26	1837.23	1864.63	1314.27
27	1584.57	1640.91	1318.58
28	--	2457.85	--
76	1740.27	--	1685.29
90	1411.62	1504.25	1275.14
100	1437.00	2128.74	1271.95
105	1078.27	1550.24	892.87
106	1738.97	2662.39	1347.51
107	--	--	1174.45
110	1980.10	2179.05	1368.70
111	2624.72	3170.42	2194.11
118	1661.61	2023.32	1345.33
119	1466.96	1863.35	1210.81
120	1898.80	2706.23	1723.79
121	1689.68	2205.97	1363.46
122	2120.34	1916.27	1431.69
123	1791.24	2187.11	1692.13
124	1446.65	3365.44	1783.24
125	2335.79	1922.44	1923.53
126	1123.47	1265.46	903.36
127	1427.12	1882.69	1106.68
128	1136.00	1903.39	984.54
129	1543.08	1871.69	1222.48
130	1847.84	2280.99	1232.31
131	1556.93	2257.46	1563.63
132	1726.24	503.67	1775.79
133	1751.44	2224.64	--
134	1749.27	2151.64	1239.22
135	1633.39	2234.94	1587.23
136	1116.48	1748.03	1079.25
137	1507.52	1841.39	1322.57
138	1303.21	1770.91	1051.11
139	1703.77	2203.67	1387.60
140	1468.62	1947.42	1150.59
141	1722.55	1923.22	1304.88
142	1872.10	1983.61	1481.69
143	2279.21	2020.87	1197.95
144	1105.84	1743.35	1041.14
145	1976.38	2029.91	1567.72
146	2132.40	1978.10	1772.07
147	1761.94	1841.31	1261.71
148	984.83	2194.31	1696.83
149	1590.57	1510.53	1327.50
150	1181.11	1711.25	1127.09
151	1212.47	1740.03	1148.93
152	1893.35	2399.51	1535.08
153	1951.69	1783.36	1450.00

Table 3-6(b) (Continued)

House #	1983	1982	1981
154	--	2012.84	1266.95
155	1465.88	1669.01	1262.08
156	1737.87	2049.14	1225.83
157	2791.19	3444.78	1455.58
158	1634.10	1637.48	1089.59
159	1269.56	1700.98	1543.88
160	1664.34	2490.13	1330.42
161	1319.45	1470.13	1060.22
162	1970.87	2583.64	1712.69
163	1879.88	2185.62	1461.79
164	1541.29	1467.99	778.27
165	1631.97	1863.80	1415.43
166	1691.98	1815.68	1080.38
167	1578.98	2194.67	1572.08
168	1231.73	1337.18	818.00
169	1917.35	2047.99	1318.98
170	1209.33	1703.88	1318.44
171	1592.91	2188.97	1616.59
172	1782.95	1967.60	1624.40
173	2077.31	1845.75	1579.53
174	1394.41	1529.86	1405.45
175	2580.08	2341.58	1692.90
176	2540.58	2461.95	2024.50
177	1349.93	1561.19	1055.92
178	1934.60	2780.13	1778.72
179	1841.81	1591.01	1536.09
180	1264.66	1742.60	1187.54
181	1219.55	1346.03	1174.25
182	1575.13	1563.29	1132.88
183	945.86	277.13*	1523.44
184	1389.32	1021.34	914.11
185	1469.79	1990.67	1308.48
186	1809.76	2514.93	1587.64
187	893.68	776.44	258.98
188	1946.94	2113.71	1006.05
189	2526.72	2618.58	1854.03
190	1865.31	3015.24	1513.92
191	--	2143.75	1320.70
192	2028.14	2862.15	1047.73
193	1035.43	2456.42	1267.54
194	1243.34	2439.19	1260.59
195	1996.92	2017.83	1704.13
196	2312.01	2579.31	1786.28
197	2288.84	2301.85	1605.08
198	--	1782.96	1392.48
199	1662.72	2066.36	1300.06
200	1719.91	1769.26	1291.38
201	2100.60	2580.91	1650.85
202	1587.17	1687.25	1114.84
203	1482.23	1950.01	1200.34
204	1544.10	1947.18	1338.41
205	1563.27	2286.81	1381.41
206	1570.44	1974.11	1278.25

Table 3-6(b) (Continued)

House #	1983	1982	1981
207	1620.13	2138.55	1324.36
208	1412.95	197.21*	1230.36
209	2070.20	2227.46	1494.82
210	1357.03	1839.44	1068.28
211	1889.12	2671.64	1713.73
212	2678.52	3655.26	1823.67
213	2287.25	218.03*	1156.60
214	1641.55	1462.62	1372.22
215	2166.85	2191.85	1475.55
216	2128.67	2246.68	1369.89
217	1478.57	2478.81	1581.59
218	2076.69	2233.87	1578.94
219	1670.75	1829.94	1734.32
220	2432.97	3181.05	1103.52
221	1934.78	2140.93	1097.40
222	1996.23	2799.40	1780.82
223	2652.72	4462.80	2132.74
225	1202.27	1377.57	1637.12
226	1223.85	1468.55	555.66
227	2218.75	2829.98	1670.66
228	1777.05	2654.97	1018.66
229	1772.03	2045.67	1148.68
230	925.92	2366.78	2527.30
231	1494.33	1889.83	842.21
232	2433.57	3312.90	1505.84
234	1327.69	1890.80	1724.78
235	957.40	1458.92	899.72
236-A	2020.72	1633.35	--
236-B	2300.98	2103.01	--
237-A	1949.14	1925.46	--
237-B	1546.00	1968.76	--
238-A	2401.72	1924.26	--
238-B	1515.00	1842.85	--
239-A	1267.30	260.54*	--
239-B	1933.78	345.98*	--
240-A	2176.74	252.47*	--
240-B	1852.00	303.45*	--
241-A	1505.34	339.60*	--
241-B	1830.15	340.45*	--
Total:	235,777.86	274,025.75	175,803.37
$\bar{x}$:	1721.01	2091.80	1373.46

* Year incomplete: data not included.

Table 3-7 Summary of Heating Oil Consumption -- Kuujjuaq

	1984	1983	1982	1981
Quantity Consumed (x 1,000 litres)	654.5	598.5	697.2	428.1
Normalized Consumption ($l/m^2/DD$)*	.0083	.0076	.0091	.0066
Actual Cost (x 1,000 $)	335.3	283.0	307.0	176.0
Normalized Cost ($\$/m^2/DD$)*	.0043	.0036	.0040	.0027
Cost in 1981 Dollars (x 1,000 $)	264.9	236.0	273.8	176.0
Normalized Cost in 1981 Dollars ($\$/m^2/DD$)*	.0034	.0030	.0036	.0027

Note * Calculated using an average heated floor area per house of 65.8 m^2 for all years. The yearly heating degree days (DD) were calculated directly from monthly weather data available to April 1984 for Kuujjuaq.

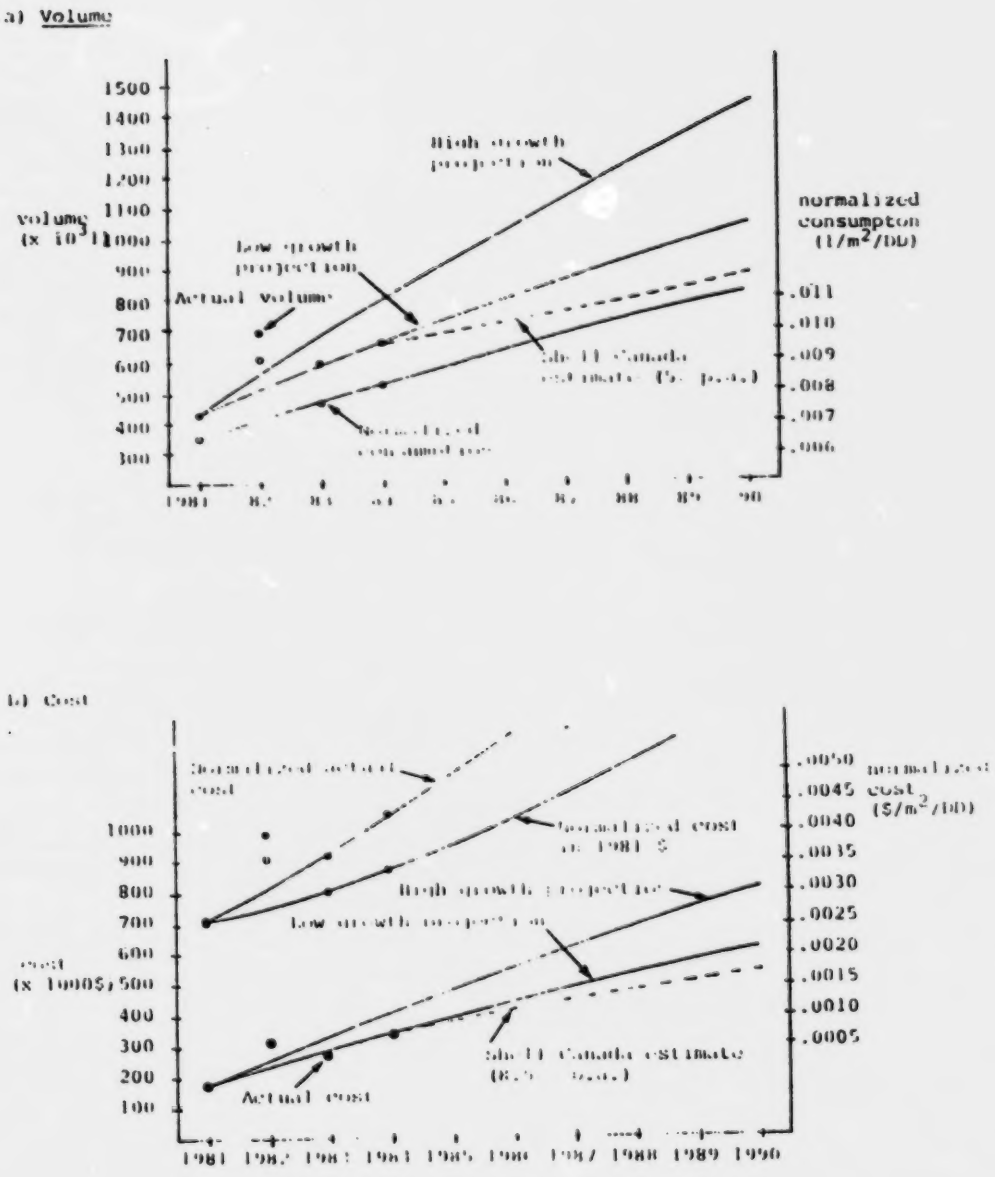


Figure 3-F Furnace Oil Consumption and Cost -- Kuujjuaq

Oil Cook Stoves: Over 70% of the houses in Kuujjuaq are equipped with oil cook stoves. Therefore, when furnace oil computations are conducted for such houses, cooking fuel is included in the data. Because cook stoves are frequently used as complementary heating systems, the two end uses are not really distinct.

For Kuujjuaq it has been possible to separate those houses which do not use oil cook stoves from those which do. Thirty-nine houses out of the sample of nearly 140 in each of 1983 and 1984 were identified as cooking with electricity. Furnace oil consumption data on these 39 houses has been tabulated in Table 3-8 and the mean consumption compared with the mean consumption of those houses which cook with oil.

The data reveals that the mean fuel oil consumption is lower in those houses with electric cookstoves. However, the 1983 data shows the difference to be only 2% while in 1984 the difference was 16%. It is difficult to draw conclusions on the effects of oil cook stoves on total oil consumption particularly since the house to house usage patterns and thermal performance variations are so large. In addition, those houses with electric cook stoves tend to be newer or renovated buildings thus the oil consumption might be expected to be lower in any case.

Oil Water Heater: No data is available concerning the oil consumption of water heaters. However, SHQ has agreed to supply the project with on-line oil meters for the heaters. Therefore, consumption data will be available in the near future.

Fuel Consumption in Municipal Vehicles: On the assumption that a little information is better than none, some data is presented here on vehicular fuel consumption in Kuujjuaq. The only records accessed were those for the municipality vehicles in Kuujjuaq. This data is presented in Table 3-9 for 30 vehicles which consume gas and from four to seven vehicles which use diesel fuel. The information covers the years 1981 through 1983.

Table 3-8 Furnace Oil Consumption for SHQ Houses in Kuujjuaq Without Oil Cookstoves

House #	1984	1983	House #	1984	1983
23	1574	3956	207	3328	4017
24	2167	6201	208	2048	3538
27	2067	6037	210	2856	3367
119	2356	6911	215	3154	5393
126	1281	3260	221	2464	4796
133	3564	5086	229	3185	5219
151	2163	3018	234	2282	3294
160	3408	4117	235	1982	2374
168	2086	3064	236-A	3573	5014
170	2532	2992	236-B	3551	5706
171	1696	3967	237-A	4301	4854
172	2125	4450	237-B	4041	3851
175	1783	6455	238-A	4662	5952
179	1509	4556	238-B	3603	--
182	2218	3926	239-A	--	3189
184	1600	3432	239-B	3916	4804
187	1065	2217	240-A	4093	5423
193	2130	2573	240-B	3336	4609
194	2326	3087	241-A	3477	3751
196	3435	5920	241-B	4041	4553

	1984	1983
Total:	106,978	168,929
n :	39	39
$\bar{x}$:	2743	4332
s :	938	1200

Fuel Consumption of Houses With Oil Cook Stoves

Total:	318,165	429,586
n :	100	97
$\bar{x}$:	3182	4429
s :	863	1096

Table 3-9 Fuel Consumption for Municipal Vehicles in Kuujjuaq

Year	Diesel			Gasoline		
	# of Vehicles	Gallons	Litres	# of Vehicles	Gallons	Litres
1981	4	2821.6	12810	30	11306.4	51331
1982	7	3028.0	13747	30	23952.6	108745
1983	6	2999.1	13616	30	26538.4	120484

Propane: Propane gas represents a minute part of the total fuel used in Kuujjuaq. Two of the SHQ houses (#119 and #108) have propane cook stoves, consuming, according to Jim Walsh, about four 100 lb. cylinders each year. Six of the KRG houses currently use propane for cooking, however these will be replaced before the end of 1985 by electric stoves.

Other Fuels: No records have been found concerning the consumption of fossil and other fuels which do not fit into the above categories. Camping gas supplies are available in Kuujjuaq, however the amount consumed is unknown. It is, nevertheless, minuscule compared with the consumption of other fossil fuels.

3.3.2 Electricity

Electricity consumption data for all SHQ houses in Kuujjuaq is presented in Tables 3-10 and 3-11 for the three year period ending in 1984. Table 3-10 gives the kWh consumed in each house and Table 3-11 gives the cost of this consumption for each building. Included with the tables are the total annual consumption and cost figures for the buildings, the mean consumption and cost for the houses and the standard deviation of the data presented.

Since the consumption and cost data in Tables 3-10 and 3-11 are available for only half of the year 1984, an estimated consumption for the whole year has been calculated based on electricity consumption patterns in 1983. From 1983 records, eight houses wre randomly

selected. Their volumes and costs of consumption were totaled for the first six months, or three billing periods, and these results compared with the total annual electricity consumption and cost figures for the year. The ratio of:

$$\frac{\text{total for the year}}{\text{total for the first six months}}$$

gives a multiplication factor which can be used to estimate the 1984 consumption and cost totals for all the SHQ housing.

The multiplication factors and projected 1984 annual total consumption and cost figures are given in Table 3-12.

The 1982 data for electricity cost is high since some of the household cost data contains arrears as far back as April 1981. All the arrears appear on the bills for the first two-month period in 1982. To readjust the data to more accurately reflect the 1982 consumption, the mean bi-monthly cost data for the last ten months of 1982 for ten randomly selected houses was used as the data for the first two-month period for these same ten houses. The resulting projected total data for 1982 for the ten houses was then compared to the non-adjusted total for these same houses to obtain a correction factor for the 1982 total cost data for all houses. The value of this correction factor was determined to be 0.70. The cost data recorded for the year 1982 was then multiplied by this correction factor to obtain a reasonable estimate for the actual 1982 cost total. From Table 3-11, the total 1982 cost was given as $85,244.79. The readjusted total for 1982 is thus:

$$\$85,244.79 \times 0.70 = \$59,671.00$$

This correction factor was assumed to be applicable to the 1982 consumption volume data of Table 3-10 as well. The readjusted total consumption for 1982 is thus:

$$1,232,190 \times 0.70 = 862,533 \text{ litres plus the total for the six houses from May onward}$$

$$= 862,533 + 46450 \text{ litres}$$

$$= 908,983 \text{ litres}$$

Table 3-10 Electricity Consumption in kWh for SHQ houses in Kuujjuaq

House #	1984	1983	1982	
23	7420	6890	10343	
24	3200	4050	7525	
25	4580	7740	11470	
26	5160	5620	11560	
27	6180	7640	9713	
28	--	--	--	
76	4910	6250	8357	
90	1440	3130	2934	
100	1460	3470	3997	
105	1880	2070	1571	
106	2040	3760	4887	
107	--	--	3389	(Jan.&Feb.only)
110	2170	3820	6797	
111	720	1990	3077	
118	2970	9080	6490	
119	4320	5620	9974	
120	3120	2380	5600	
121	5000	9240	13600	
122	4330	7980	1338	
123	1820	3670	3433	
124	2410	1230	2792	
125	2910	3510	6983	
126	5960	3360	9327	
127	3220	10800	11966	
128	7090	8490	12022	
129	5520	9630	12536	
130	4590	9860	12625	
131	1580	2760	5860	
132	2540	3880	4547	
133	6130	13190	20940	
134	4560	9160	13703	
135	4790	6870	15052	
136	3320	6440	9770	
137	2410	3150	4830	
138	3410	6600	9450	
139	4450	8790	11783	
140	6100	8640	10128	
141	2250	3970	6210	
142	1870	4390	6590	
143	3110	1510	1089	
144	6300	7970	13634	
145	1840	2900	3130	
146	1980	3230	4510	
147	2520	3860	6431	
148	1270	11780	9044	
149	1780	2890	5426	
150	1430	2390	8014	
151	5250	8910	7081	
152	3990	7460	11213	
153	2560	4060	6340	
154	1540	1290	5543	

Table 3-10 (Continued)

House #	1984	1983	1982
155	3690	6930	8408
156	1740	6352	9873
157	2770	4610	7495
158	2630	2330	7701
159	3460	5100	7526
160	4030	7580	7127
161	--	--	--
162	2010	5470	6646
163	2950	5580	7864
164	5690	11380	14635
165	4460	8260	10946
166	--	--	--
167	3820	6060	10820
168	5320	11280	19341
169	2660	4710	8571
170	3650	7110	10520
171	6460	7690	9070
172	5970	9060	7308
173	4690	9340	11760
174	4580	9740	11880
175	6420	8330	13099
176	10010	15240	13550
177	2720	4270	5904
178	870	2480	4273
179	5380	5600	8282
180	2530	3720	6679
181	3750	10270	11930
182	4850	5690	8005
183	1900	4380	4367
184	3560	6610	4889
185	1220	3130	3920
186	710	2600	2931
187	13030	21550	35616
188	3310	2970	3906
189	3720	2910	8231
190	3510	3630	4421
191	10120	16430	32604
192	2460	4170	4606
193	4820	10330	6265
194	6570	11350	12907
195	3190	5400	9150
196	1950	3580	7485
197	1440	3070	4287
198	2030	5160	4830
199	4460	7570	9956
200	4450	6770	11340
201	4240	8460	18625
202	2980	5260	8870
203	2770	5840	9110
204	7060	12790	15295
205	2250	5040	9147
206	6560	10190	16079
207	3170	4970	8124
208	5880	11360	17831
209	4800	9610	14679
210	18170	20850	36166

Table 3-10 Electricity Consumption in kWh for SHQ houses in Kuujjuaq

House #	1984	1983	1982
211	5490	6600	10751
212	1220	3330	missing
213	1520	4340	3699
214	17670	1920	13922
215	13210	16030	23688
216	6790	18460	16229
217	4060	6990	9851
218	5410	8060	14916
219	4670	8280	12096
220	6600	17690	--
221	5930	9150	20154
222	1990	6330	7961
223	4820	5930	6268
225	280	1220	2748
226	7820	16600	20795
227	4460	9960	11946
228	3500	7290	10865
229	3800	7000	14929
230	4960	11110	13904
231	4590	7370	10221
232	7660	17050	12330
234	8930	11100	12360
235	6940	9750	13024
236-A	5220	10480	6970 (from May only)
236-B	5870	11900	8350 (from May only)
237-A	7170	11170	6670 (from May only)
237-B	9030	14390	4160 (from May only)
238-A	6760	14310	11180 (from May only)
238-B	5900	14760	9120 (from May only)
239-A	--	13500	
239-B	7620	10850	
240-A	6430	10700	
240-B	8850	13980	
241-A	8450	12760	
241-B	7660	10880	
241-B			
Total:	620100	1038750	1232190
n :	137	138	124
$\bar{x}$:	4526	7527	9937

Table 3-11 Electricity Costs of SHQ Houses in Kuujjuaq
(in dollars)

House #	1984	1983	1982
23	827.98	516.70	428.96
24	149.64	227.95	349.27
25	339.53	474.89	452.95
26	443.40	271.12	453.83
27	631.26	579.97	450.50
28	-----	----	----
76	396.30	367.43	381.28
90	95.36	182.60	220.76
100	95.47	259.62	251.08
105	109.60	165,74	181.80
106	114.49	220.25	276.56
107	----	----	149.25
110	123.18	222.00	329.02
111	56.96	162.62	224.03
118	111.61	361.49	322.94
119	230.53	339.23	428.13
120	121.96	191.17	297.71
121	414.70	678.69	805.12
122	301.24	514.74	738.52
123	107.53	217.24	235.38
124	239.33	138.77	217.13
125	143.87	211.82	392.56
126	593.20	208.05	421.71
127	152.63	1097.47	708.87
128	790.83	577.00	582.67
129	514.88	745.51	652.99
130	340.90	786.70	866.73
131	99.81	187.15	300.79
132	130.42	223.01	229.48
133	622.34	1510.66	2204.95
134	497.47	661.74	854.69
135	376.46	585.00	1009.24
136	159.96	334.77	415.88
137	126.20	222.81	274.67
138	179.12	366.16	411.83
139	316.84	609.73	612.98
140	614.68	755.58	491.95
141	120.56	227.04	314.58
142	109.40	240.59	325.00
143	211.80	147.47	160.46
144	650.56	734.47	929.97
145	108.01	191.96	226.52
146	112.65	203.14	265.84
147	129.41	222.51	318.93
148	68.90	1195.49	391.04
149	106.17	191.76	323.36
150	94.80	143.63	363.27
151	468.16	770.03	336.88
152	319.69	556.97	637.92
153	130.73	229.11	318.16

Table 3-11 (Continued)

House #	1984	1983	1982
154	98.31	140.24	251.87
155	187.58	405.17	392.91
156	86.32	361.94	423.48
157	137.75	316.16	350.68
158	132.52	168.82	390.90
159	197.53	305.61	407.64
160	239.05	492.08	420.03
161	----	----	----
162	95.27	274.93	327.05
163	143.43	284.35	433.52
164	534.07	1055.50	1000.44
165	325.62	522.04	513.40
166	----	----	----
167	338.91	311.94	538.79
168	472.52	1162.16	1717.37
169	131.15	249.39	380.64
170	218.26	358.63	527.19
171	682.21	589.18	418.28
172	594.70	687.39	369.91
173	360.59	688.90	475.06
174	339.42	761.03	494.89
175	676.78	696.63	741.04
176	1266.87	2285.60	767.72
177	136.23	236.29	304.06
178	59.30	178.10	258.04
179	484.44	325.27	369.95
180	129.94	218.57	323.87
181	316.37	854.75	502.75
182	406.80	463.93	381.25
183	109.51	193.61	259.29
184	192.14	458.87	275.14
185	87.93	153.68	249.52
186	72.69	182.19	220.73
187	1906.71	3701.81	4386.90
188	200.02	194.16	247.91
189	316.73	268.01	327.53
190	273.69	215.55	263.59
191	1344.73	1941.32	3884.82
192	128.03	232.68	269.87
193	381.60	986.26	315.47
194	691.53	1113.74	860.21
195	152.41	409.67	406.81
196	127.82	214.50	301.32
197	95.28	197.89	260.66
198	439.42	648.57	275.88
199	316.19	466.96	476.61
200	339.72	376.03	648.37
201	280.65	587.46	1636.67
202	144.89	268.24	313.79
203	137.80	333.88	457.31
204	794.64	1345.40	1155.60
205	119.83	916.71	414.15
206	705.85	1209.01	1327.87
207	150.63	330.78	484.48
208	576.28	1050.06	1804.42
209	507.66	802.33	1766.38

Table 3-11 (Continued)

House #	1984	1983	1982
210	2748.39	3938.71	3628.20
211	337.82	584.55	517.76
212	67.88	271.20	303.54
213	98.18	292.88	224.09
214	2353.12	224.35	842.48
215	1906.13	2315.77	2578.70
216	746.28	1943.25	1216.70
217	242.08	789.54	463.04
218	488.84	755.42	994.87
219	355.21	508.54	737.07
220	707.94	959.57	----
221	583.24	671.08	1860.99
222	123.07	562.99	418.10
223	377.65	354.24	349.86
225	43.81	138.61	214.99
226	924.96	1974.65	1945.59
227	370.82	791.52	573.72
228	178.47	484.72	560.03
229	256.20	448.85	1003.33
230	396.88	1000.68	966.96
231	358.84	445.59	474.82
232	907.20	2129.21	568.46
234	1136.47	1191.69	573.37
235	773.87	725.94	794.85
236-A	457.21	851.88	588.82
236-B	574.07	1115.17	804.84
237-A	810.47	1011.63	287.00
237-B	1148.39	1552.37	783.71
238-A	738.31	1540.63	854.28
238-B	580.84	1610.90	802.40
239-A	----	1738.87	----
239-B	892.68	1128.34	----
240-A	675.07	1128.92	----
240-B	1123.36	1690.64	----
241-A	1044.45	1461.14	----
241-B	904.75	----	----
Total:	$58019.65	$92265.40	$85244.79
n :	137	138	132
$\bar{x}$:	423.50	668.59	645.79
s :	430.88	630.10	665.86

Table 3-12 Estimate of Projected Annual Electricity Consumption and Costs for 1984 for Kuujjuaq

1983	Total for first six months (A)	Total for twelve months (B)	Multiplication factor (B/A)
kWh	43200	76050	1.76
Cost ($)	4594.34	7621.25	1.66

1984	Total for first six months	Multiplication factor	Projected Annual Total
kWh	620,100	1.76	1,091,376
Cost ($)	58,019.65	1.66	96,312.62

A summary of the electricity and cost information for Kuujjuaq for the years 1982 through 1984 is given in Table 3-13.

Table 3-13 Summary of Tabulated and Estimated Consumption and Cost Data for Electricity Use in Kuujjuaq

	1984	1983	1982
Consumption (MWh)	1091.4	1038.8	909.0
Cost (x 1,000 $)	96.3	92.3	59.7
Cost in 1981 Dollars (x 1,000 $)	76.1	77.0	53.2

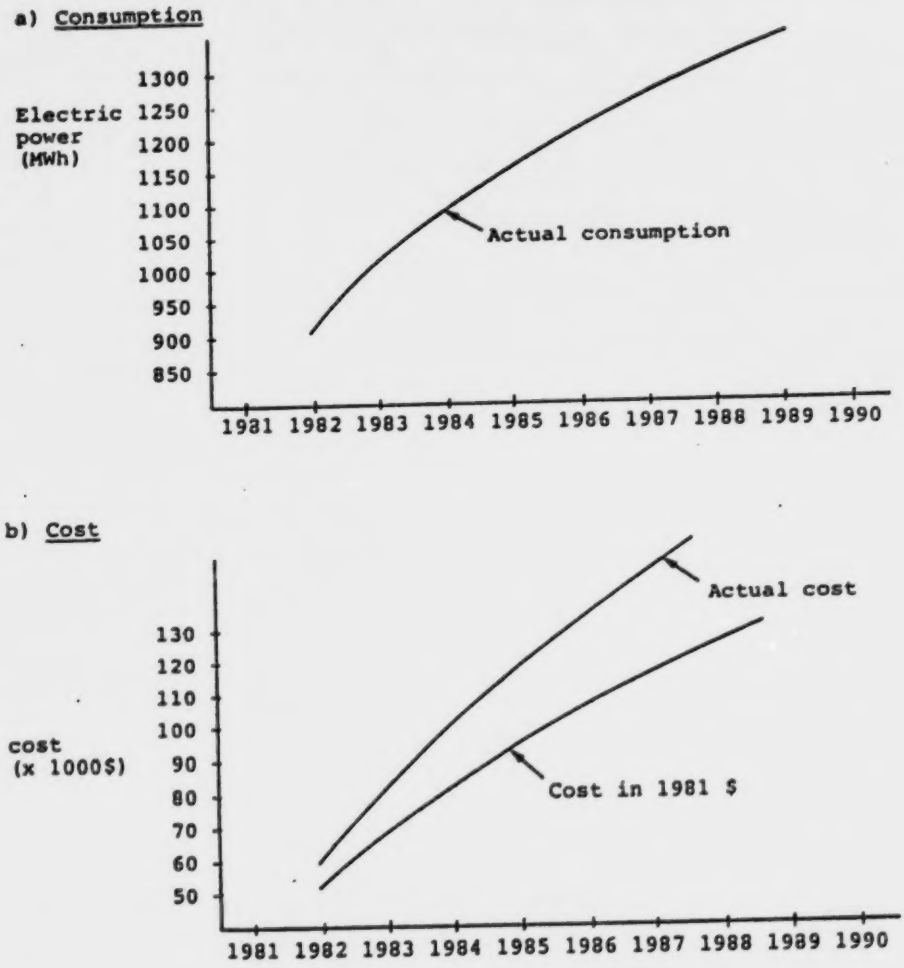


Figure 3-G Electricity Consumption and Cost -- Kuujjusq

Figures 3-G(a) and (b) are plots of the consumption and cost data of Table 3-13. Projections of cost increases are based on consumption increases plus expected cost increases per unit of electricity.

From the data in Table 3-13 or the graph in Figure 3-G(a), it can be seen that the average rate of increase in quantity of household electricity consumed over the period 1982-1984 was 10%. During the same period the cost to the community for this electricity increased at an annual average of 30% in actual dollars spent or 22% in terms of 1981 dollars.

Electric Cook Stoves: Less than 30% of the houses in Kuujjuaq are equipped with electric cookstoves. As new and renovated houses gradually replace existing housing stock, the percentage of houses with electric cook stoves will increase. Thus it is interesting to determine if the available data identifies a significant increase in domestic electricity consumption due to use of these stoves, and what the average value of this increase is. Total household use of electricity is tabulated in Table 3-14 for all of 1983 and half of 1984 for all SHQ houses equipped with electric cook stoves.

The average electricity consumption per house with an electric cook stove is compared, in the same table, with the average electricity consumption per house without an electric cook stove. The comparison reveals that houses equipped with electric stoves show a significantly higher average consumption, within a 95% confidence level, than homes without electric stoves. Over the period for which data is presented houses with electric cook stoves consumed 62% more electricity than houses with other types of cook stoves. To state that all the increase in electricity use in these houses is due to the electric stoves would be misleading. Most of the houses with electric stoves are new or renovated buildings with, in general, considerably more electrical services and appliances than their older counterparts.

3.4 Hydro-electric Potential for Kuujjuaq

Three sites have been identifed by Hydro-Quebec as potentially capable of supplying the projected electrical energy demand for Kuujjuaq in the

Table 3-14 Electricity Consumption in kWh for SHQ Houses in Kuujjuaq Equipped with Electric Cook Stoves

House #	1984 (6 months)	1983	House #	1984 (6 months)	1983
23	7420	6890	207	3170	4970
24	3200	4050	210	18170	26850
27	6180	7640	215	13210	16030
126	5960	3360	221	5930	9150
133	6130	13190	229	3800	7000
151	5250	8910	234	8930	11100
160	4030	7580	235	6940	9750
168	5320	1280	236-A	5220	10480
170	3650	7110	236-B	5870	11900
171	6460	7690	237-A	7170	11170
172	5970	9060	237-B	9030	14390
175	6420	8330	238-A	6760	14310
179	5380	5600	238-B	5900	14760
182	4850	5690	239-A	--	13500
184	3560	6610	239-B	7620	10850
187	13030	21550	240-A	6430	10700
193	4820	10330	240-B	8850	13980
194	6570	11350	241-A	8450	12760
196	1950	3580	241-B	7860	10880

	1984	1983
Total:	245,260	384,330
n :	37	38
$\bar{x}$:	6629	10114
s :	3051	4907

HOMES WHICH USE OIL OR PROPANE STOVES

Total:	374,830	660,462
n :	100	100
$\bar{x}$:	3748	6604
s :	2389	3851

year 1990.

Site 1 - on False River, 42.5 km from its mouth
Site 2 - on the Nepijbee River about 10 km from its mouth
Site 3 - at the mouth of High Falls River, 10 km from Kuujjuaq, across the Koksoak River.

Site 1 was rejected because of the clay soil formations, the large size of dam required, and the distance from Kuujjuaq. Site 2 was also eliminated from further consideration because of the dam size and the extensive site preparations necessary. Site 3 was considered as potentially interesting because of the limited necessary site preparations and due to a solid rock base in the immediate vicinity.

Site 3 description:

drainage basin	- 725 km^2 upstream of the site
average river flow	- 12.2 m^3/sec
minimum river flow	- 0 m^3/sec from February to May
hydraulic head	- 40 m
turbine	- francis, 3.77 MW nominal power
project cost	- $25,328,900 in 1982 dollars
cost/kW	- $6718

Projected electrical energy demand for the year 1990 and estimated output of the proposed site are given in the following Table 3-15.

Hydro-Quebec concluded from its brief study of High Falls River that the site has interesting possibilities due to its proximity to Kuujjuaq and the simplified preparations necessary. The power transmission lines could be constructed along the far shore of the Koksoak River and cross to Kuujjuaq via the islands in the river in front of the settlement.

Table 3-15 Projected Electrical Energy Demand and Estimated Production of Hydro Site 3 for Year 1990

Month	Energy Demand (GWh)	Energy Produced (GWh)
October	1.33	1.33
November	1.44	1.44
December	1.91	0.68
January	2.08	0.31
February	1.82	*
March	1.71	*
April	1.47	*
May	1.15	1.15
June	0.96	0.96
July	0.76	0.76
August	0.83	0.83
September	0.98	0.98
Total	16.44	8.44 (51% of demand)

* Assumed that there is no water flow in the river from February to May.

Source: Petites Centrales Peninsule D'Ungava: Evaluation Sommaire. Hydro Quebec, Direction Ingeniere de Centrales, Vice Presidence Ingeniere et Construction, Montreal. March, 1983.

4.0 DATA RELEVANT TO BOTH KANGIRSUK AND KUUJJUAQ

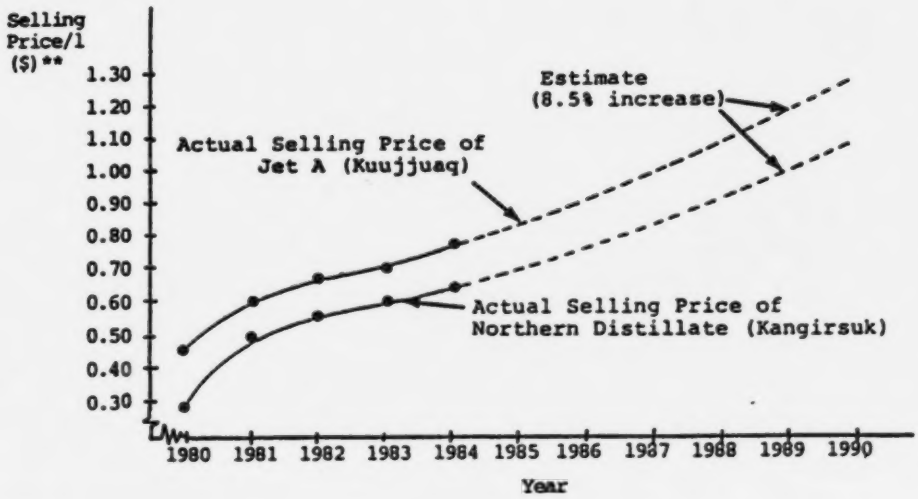
4.1 Fossil Fuel Prices

Actual and expected pricing for fossil fuels in both Kangirsuk and Kuujjuaq are presented in Figure 4-A. Furnace oil prices are given in Figure 4-A(a) and gasoline prices in Figure 4-A(b). Gasoline prices are the same in both communities, however furnace oil prices are considerably different in the two communities. The price difference does not reflect transportation cost differences, rather it is a direct pricing difference for the type of fuel used as furnace oil.

4.2 Typical Household Energy Consumption in Southern Canada

Data is presented in Table 4.1 on the average annual energy consumption per household in a southern Canadian city. This data is given here only as a comparison with data presented earlier for Kangirsuk and Kuujjuaq. No attempt has been made to convert the energy use figures into litres of furnace oil equivilent or kWh.

a) Heating Oil



b) Gasoline

FIGURE 4-A Shell Canada Heating Fuel and Gasoline Prices in Northern Quebec

Table 4-1 Average Annual Energy Consumption per Household
Kitchener, Ontario, 1980

End Use	House Type	Fuel Type	Energy Use (GJ)
Space Heating	SFD	oil	211.6
	ATT	oil	138.2
Water Heating	SFD	electric	20.5
	ATT	electric	18.2
Appliances	SFD	electric	14.1
	ATT	electric	14.1
Total	SFD		246.2
	ATT		170.5

Source: Spence, David H. The Development of a Residential Energy Management Strategy for the City of Kitchener, Ontario. Thesis for a Master of Arts in Regional Planning and Resource Development. University of Waterloo, Waterloo, Ontario, 1984.

Note: SFD = Single Family Dwelling
ATT = Attached Dewelling (row houses, duplexes)

4.3 Insulation Levels in New and Renovated SHQ Housing

Data on insulation levels in new and renovated SHQ housing has been obtained from SHQ dossiers for eleven house designs for northern Quebec. This information is given in Figure 4-B. The data is presented as the RSI value of the insulation in the ceilings, walls and floors of the houses by year of house design. One house was designed for construction in 1980, four in 1981, two in 1982, three in 1983 and one in 1984.

An interesting observation to make is that the levels of ceiling and floor insulation have been gradually decreasing in the designs since 1980.

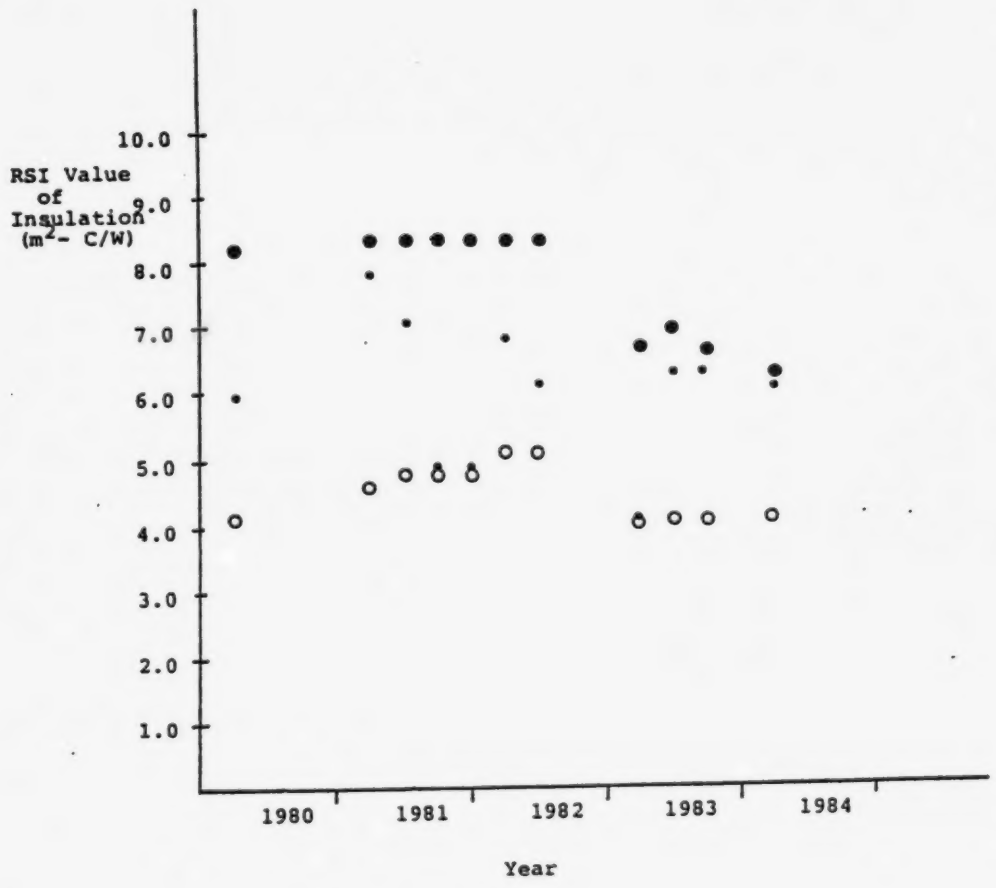
4.4 Renewable Energy and Energy Conservation

Information on the use of renewable energies and technologies relating to energy conservation in Northern Quebec is virtually non-existent. No renewable energy resource has received in-depth study and most have been virtually neglected. Hydro-Quebec has identified several potential hydro-electric sites near Kangirsuk and Kuujjuaq. These have been reviewed in sections 2-4 and 3-4 above. In addition, tidal power has received some attention. Several sites have been identified on Ungava Bay as potentially suitable for tidal power installations for a total installed capacity of 26,000 MW. However, development of these sites is not considered feasible in the near future.

Wind energy data from the coastal regions of Ungava Bay indicate promising potential for the production of electrical energy adequate to meet all the demand in communities along the coast. However, no engineering analysis of the feasibility of installing windmills has been made.

A similar situation exists with respect to solar energy. Although seasonally more restricted, solar energy may have significant potential from March through October for space and/or waterheating.

Biomass in the region is essentially non-exploitable.



Source: SHQ Habitation Nordique dossiers for 11 new and renovated house designs

Figure 4-B Insulation Levels in New and Renovated SHQ Housing, 1980-1984

Energy conservation information is available in studies and texts written about similar communities elsewhere in northern Canada, although none was found relating directly to northern Quebec.

In the sub-sections that follow, the information available on these renewable energy and conservation technologies is presented.

4.4.1 Tidal Power

According to La Direction Generale de l'Energie in 1981, Ungava Bay has some of the highest tides in the world, reaching 16 to 18 metres between high and low tides. Hydro-Quebec has identified 9 sites potentially suitable for tidal power installations (see Table 4-2) for a total installed capacity of 26,400 MW. The average capacity of all these sites would be about 5600 MW for a potential energy production of 178×10^6 GJ/year.

Development of such sites is not considered feasible in the near future given current knowledge of ice and water conditions in the far north as they relate to tidal power installations and given current non-competitive costs for such installations elsewhere in the world. Other obstacles to immediate implementation include uncertainties concerning marine current changes resulting from the installations.

Table 4-2 Tidal Energy Potential around Ungava Bay

Site	Power Capacity	
	Total/installed(MW)	Average/installed (MW)
Payne Bay	3432	726
Ykattok Bay	1716	378
Leaf Bay	10656	2253
Koksoak Bay	2244	475
False River	2604	566
Whale River	2356	504
George River	2376	507
Keglo River	552	115
Abloviak	480	97
Total	26416	5621

4.4.2 Wind Power

Theoretically, the potential of generating large amounts of electrical power from the wind is very high. Federal and Provincial weather stations scattered throughout northern Quebec indicate that coastal zones have the best winds, in the order of 22-24 km/h for the mean annual hourly wind. Typical wind data is presented in Appendix D, pages D-17 through D-20. Interior regions also have reasonably good winds, with most areas reporting mean annual winds in excess of 16 km/hr and many locations averaging 20 km/hr. No in-depth analysis of the potential for untilizing wind power in the Ungava Bay area has been encountered during the course of the present study. However, from a preliminary estimate, it would appear that wind energy could eventually provide for all of the electrical energy demand in communities around Ungava Bay.

Technical limitations to the use of wind energy are in the near-term only. Advancements are needed in the current technology to make it suitable for the north. Lower investment costs relative to other energy developments and lower transportation costs will also help to make this a viable alternative.

4.4.3 Biomass

Living biomass in the Ungava Bay area has a very low productivity per unit area of land surface. This renders biomass essentially unexploitable.

4.4.4 Solar Power

The potential for using solar energy in both Kangirsuk and Kuujjuaq is very high. On an annual basis Kuujjuaq receives some 81% of the total horizontal solar radiation that Montreal receives. This ratio increases to 87% if one considers only the period March to October, inclusive. However, the seasonal variation in available solar radiation will severely limit its usefulness during the winter months of November thrcugh February. During all other months, solar power, in either the passive or active modes, can be very useful to offset oil or electric

space or water heating.

Measured solar radiation data for Kuujjuaq are presented in Appendix D, page D-16. This table gives the mean data for the period 1972-1980. No data are available for Kangirsuk. The figures on pages D-3 through D-15 are maps of the mean daily global solar radiation for each month and for the year for all of Canada. Kuujjuaq and Kangirsuk are clearly sited on these maps.

4.4.5 Energy Conservation

The potential energy savings resulting from improved energy conservation techniques applied to new or existing houses in northern Quebec are enormous. Increased insulation levels in walls, ceiling and floor, application of an air vapour barrier and reduction of infiltration around all openings can reduce heat losses conservatively by a factor of two and easily by a factor of four, when compared with the existing housing stock.

A typical heat loss analysis performed on old SHQ housing stock and the same house renovated reveals the potential savings that can be attributed to increased insulation levels and decreased infiltration rates. A HOTCAN heat loss analysis was performed on a house model 455-EX in Kangirsuk and the same house after renovation to 1982 SHQ new northern housing standards. Appendix F contains the results of the HOTCAN analysis for the old and unrenovated model 455-EX house, assuming differing natural infiltration rates. For input to the HOTCAN program, dimensions and thermal characteristics were taken from files maintained at SHQ on the specfic building before renovation. Post renovation information was obtained from architectural drawings entitled Renovation Architecture 455-EX 82. Indoor temperature was assumed to be 20 ^{o}C with an allowable daily temperature swing of 6 ^{o}C. Weather data used is the data for Kuujjuaq on file in HOTCAN with a degree day modifier to reflect cooler overall conditions in Kangirsuk. Comparative analysis, assuming equivalent natural infiltration rates of two air changes per hour, reveals that the estimated annual space heating load for the unrenovated house is 31,560 kWh. For the renovated house, the estimated annual space heating load is 23,481 kWh. Since the renovated house is

larger than the unrenovated house, the comparison is more approriate if the space heaing loads are normalized to unit of heated floor area. The corresponding values are as follows:

old house (floor area 59 m^2) : space heating load = 535 kWh/m^2

renovated house (floor area 76.5 m^2) : space heating load = 307 kWh/m^2

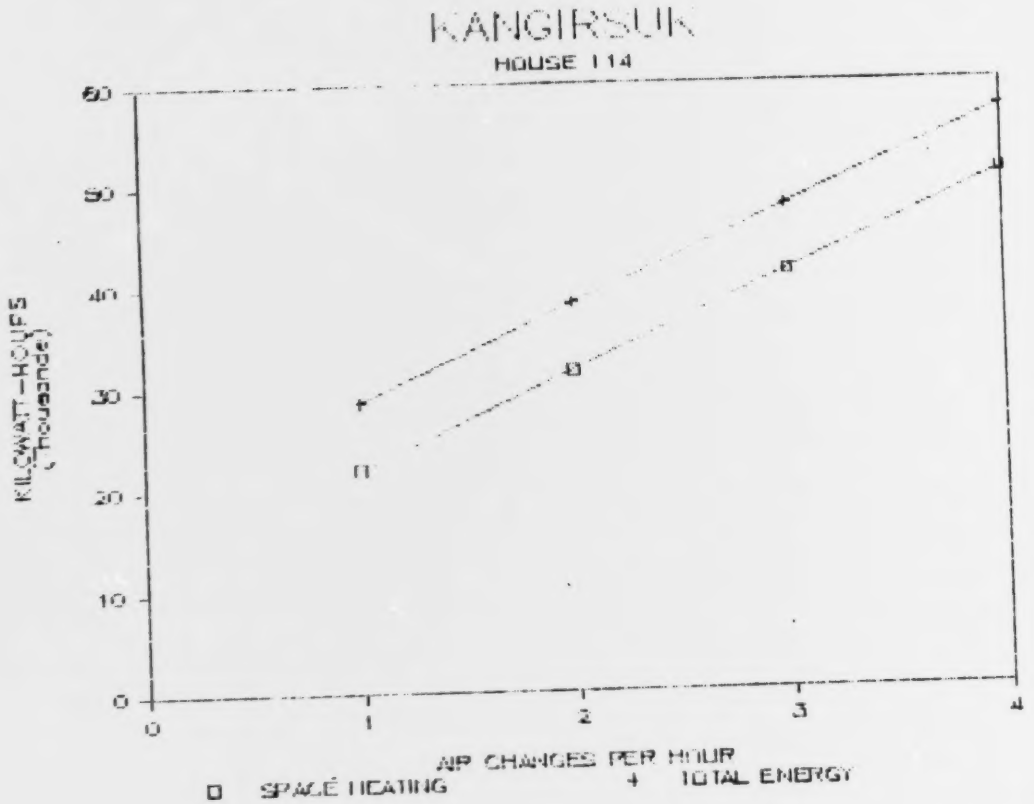
This indicates that increasing insulation levels to the 1982 renovated house standards decreases heat losses by approximately 43%. On the other hand, if an attempt is made only to reduce natural infiltration, heat loss reductions can be as dramatically affected. Figure 4-C is a plot of the estimated annual space heating load for an unrenovated model 455-EX house in Kangirsuk assuming different levels of natural infiltration rates. Comparing the HOTCAN analysis of predicted performance to the performance of an existing 455-EX house in Kangirsuk indicates that the unrenovated house in 1983 operated as though it had a natural infiltration rate of three air changes per hour. Decreasing this infiltration by weather stripping and caulking all windows, doors, joints, electrical and plumbing outlets and repairing broken and cracked windows can cut the infiltration rate by half, at a conservative estimate. Thus, potential heat savings can be reduced by some 35%, judging from Figure 4-C.

Improving insulation levels of unrenovated houses to the renovated standard involves major renovations and threfore major costs. In contrast, decreasing the natural infiltration rate can be undertaken at relatively low cost.

An indication of the information available on energy conservation techniques applicable to the communities of Kangirsuk and Kuujjuaq are the 39 articles and texts referenced in Appendix E under the caption, 'Housing and Conservation'.

In addition, Appendix C includes extracts from a report which resumes design and construction details for one low energy building and one major house renovation in Armstrong, Ontario. Although the site is in an area without a permafrost layer, the report contains information relevant to design and construction needs for energy conservation in

Figure 4-C Estimated Annual Energy Consumption For SHQ House 455-EX For Various Natural Infiltration Rates



Kangirsuk and Kuujjuaq. The firgures included in Appendix C illustrate some of the analysis technique and the degree of energy conservation avialable for various levels of up-front costs.

4.5 Impact of Technologies

Energy sources and use affect all aspects of community life. Traditionally, the Inuit have relied solely on renewable energy resources for food, shelter and fuel supplies. Cultural patterns such as sharing food and fuel resources, hunting and fishing in a group, and seasonal lifestyle changes, were shaped by natural energy sources. Community life has changed radically as purchased, non-renewable supplies have been substituted. Among the most prominent effects are the adoption of a cash economy with a concomitant decrease in sharing between families; creation of larger, less migrant settlements; addition of refined carbohydrates in the diet; introduction of an institutionalized "western" educational system, and greater awareness of and dependence on the outside world. Less obvious effects include such things as increased background noise and environmental pollution from diesel generators and internal combustion engines.

Changes in modes of transportation is a good illustration of the positive and negative aspects to the community of the use of non-renewable fuels. Year round communications between settlements and between settlement and hunting and fishing grounds have been facilitated through use of fossil fuel operated boats, planes, snow mobiles and other vehicles. With this relative ease of movement has come the need to purchase fuel and thus the need to maintain a reasonably steady cash income in order to make these purchases. The capital cost of the transportation system and the fuel component of the operating costs all represent an outflow of community money. This outflow may be offset by increased income due to the more efficient transporation systems. On the other hand, the dependence on the outside world generated by the use of this transportation system is an important concern. The more vehicles purchased, the more their use is woven into all aspects of community life and thus the greater the dependence upon them. More recently, some vehicles are used primarily for recreation, giving no direct economic return although adding a new dimension to life in the north.

In housing, the shift from primarily temporary shelters to permanent

heated structures has changed the character of community life. No effort to judge these changes is being made in this report. Clearly, importation of both housing materials and heating fuel mirrors technological changes that have occurred in transportation.

Over time, more and more information is being generated to improve the quality of housing for northern regions. Newer and renovated buildings are being constructed with some concern for thermal efficiency. At the same time, the heated floor area has been expanded. The decreased heating fuel consumption expected from increased building thermal performance is at least partially offset by the increased heating requirements of the larger houses.

But in addition, as was noted in the discussion for Table 3-14, the newer and renovated houses consume significantly more electricity than do the unrenovated buildings. If one considers the conversion efficiency from oil to electricity, as revealed in Figure 3-E (1 litre of oil generates approximately 3.2 kWh of electricity), the average equivalent oil consumption of the new and renovated houses shows a 15% increase in 1983 and an 11% increase in the first six months of 1984 over the average equivalent oil consumption of the older houses (data extracted from Tables 3-8 and 3-14). The quality of life was again changed, in the form of increased and thermally more comfortable living space and increased electrical services. Once more, this was done at the expense of greater dependence on outside resources.

Conceivably, renewable energy sources and conservation technologies can serve to reduce negative and unwanted impacts. If not well planned and carried out however, they can be disruptive. Their purchase, installation and maintenance may be marginally more or less dependent on outside resources. But it is clear that the operational costs of renewable systems are significantly decreased. On the other hand, if coupled with fossil fuel systems in order to decrease oil consumption, there will be a greater number of systems that could potentially break down. Presumably, longer life can be extracted from conventional diesel-electric generators if used as back-up to, for instance, a windmill. Operating experience will be required to discover if the decreased operating costs/efforts are an advantage when compared to the

potential for more equipment failure.

The benefits of renewable and conservation technologies are most apparent with regard to local economies and environmental health. Decreasing reliance on imported fuel supplies gives a community greater resilience in the face of economic and political changes beyond their control. Minimizing pollution of the natural world results not only in greater long term security, but also a more healthful immediate quality of life.

5.0 CONCLUSIONS

5.1 Summary of Findings

The report focuses primarily on SHQ housing related energy requirements. Some evidence is presented of trends in electrical power and heating oil costs and consumption.

In Kangirsuk, Shell northern distillate is used as heating oil. In Kuujjuaq, Shell Jet A-1 serves the same purpose. Both communities use regular leaded gasoline as vehicle fuel. In Kangirsuk, heating oil consumption, normalized per square metre of heated floor area and per heating degree day, has been nearly steady over the past three years. Normalized actual cost for this fuel has been rising at about 5% per year and in terms of 1981 dollars, it has been steadily decreasing at about 3% per annum.

During this same period, electricity consumption in SHQ households has been increasing at 35% per year with cost increases of 68% per year in terms of actual dollars spent, or 50% in 1981 dollars. Families in new or renovated houses tend to consume more electricity and less heating oil per unit of heated floor area than those living in older houses.

In Kuujjuaq normalized consumption of heating oil in SHQ housing has been increasing at an average 9% since 1981. Normalized cost over the same period has risen approximately 20% per annum in actual dollars spent or 9% in 1981 dollars.

Electricity consumption in SHQ housing in Kuujjuaq has been increasing at 10% per year from 1982. At the same time the cost for this electrical power to the community has risen 30% per annum in actual dollars spent or 22% in terms of 1981 dollars.

Preliminary analysis of data from houses in Kuujjuaq with oil and electric cookstoves indicates that houses equipped with electric stoves (for the most part new or renovated houses) consume significantly more electricty and subsequently, more total energy, than houses equipped with oil cookstoves (older, unrenovated houses).

Initial studies by Hydro-Quebec reveal a potentially interesting hydro electric site at the mouth of the High Falls River, 10 km from Kuujjuaq. Installed capacity of 3.8 MW could provide 50% of the community's electricity needs by the year 1990.

5.2 Interpretation of Data

Where there was sufficient information to warrant it, some data interpretation has been carried out. Other data has been displayed without analysis or interpretation because there is not enough information presented to make adequate interpretations.

5.3 Recommendations

The Data Base Report is a first effort at accumulating and recording energy related information for Kangirsuk and Kuujjuaq. It is strongly recommended that this report be upgraded as new information becomes available. To develop a more comprehensive and inclusive data base will require continuing effort on the part of those involved in energy related concerns in each community. Specifically, the following recommendations are made:

1. The councils should upgrade their techniques of recording oil and electricity consumption for each household or building. The office computer available in each community can be of great assistance in performing this task.

2. The total annual household and other building oil and electricity consumption records should be maintained.

3. Random households in each community can be selected to maintain records over a twelve-month period of all transportation fuel purchases for the household.

4. HQ and Shell supply and consumption records should be retrieved dating back to 1970 for each community. If other suppliers of electrical power and fossil fuels existed at any time during this period, their records should be searched out.

5. The results of any on-going energy and housing related studies should be incorporated as they become available.

6. A small weather station should be established in Kangirsuk to record solar radiation, wind-speed and direction (at two locations, the village and air-strip), and temperature.

7. Data bases for each of the other Inuit communities in Northern Quebec should be developed to determine similarities, differences and anomalies.

JUL 30 1984

ANNEX A TO APPENDIX B

PERSONAL COMMUNICATION WITH SHELL CANADA

Produits Shell Canada
Une division de Shell Canada Limitée

Région commerciale de l'Est/
Eastern Marketing Region
758, rue Sherbrooke Ouest
Montréal (Québec) H3A 1G1
(514) 287-7000

July 27, 1984

Energy, Mines and Resources Canada
Guy Favreau Complex
200 Dorchester Blvd West
West Tower - Room 501
Montreal, Quebec
H2Z 1X4

Attention: Louise Millette

Dear Louise,

We thank you for your recent letter and we are pleased to provide the following information.

1. Product specifications for the following products
   - Avgas 100
   - Regular Leaded Gasoline
   - Jet A-1
   - Northern Distillate

2. a) Annual volume delivered (in K litres)

	PAYNE BAY		FORT CHIMO		
	Mogas	N.D.	Avgas	Mogas	Jet A
1980	107	707		645	11,736
1981	193	709	789	975	7,931
1982	101	774		765	6,945
1983	178	937		774	7,896
1984	191	1033	954	795	9,539

b) Selling prices

	Mogas	Jet A	Avgas	N.D.
1980/81	0.4894	0.4814	0.5078	0.3900
1981/82	0.6898	0.6132	0.6506	0.5150
1982/83	0.7766	0.6862	0.7487	0.5792
1983/84	0.7742	0.7221	0.7860	0.6142
1984/85	0.8243	0.7789	0.8405	0.6597

3. Our best estimate for future sales and prices are 5% annual increase in sales and 7-10% in price.

Should you require additional details, please contact the undersigned.

Yours very truly,

George Sztvk
Arctic Zone Accountant

SHELL CANADA LIMITÉE/LIMITED

RÉGION COMMERCIALE DE L'EST — EASTERN MARKETING REGION

Essence d'aviation Shell Avgas 100

Shell aviation gasoline 100

Essais - Characteristics	Specifications
Indice d'octane, mélange pauvre Octane number, lean mixture	100,0 min.
Indice d'octane, mélange riche Octane number, rich mixture	130,0 min.
Couleur Colour	Vert Green
Corrosion à la lame de Cu., 2hres @ 100°C Corrosion, Cu. Strip, 2hr. at 100°C	N° 1 max.
Soufre % à la masse Sulphur, % by mass	0,05 max.
Apparence Appearance	Limpide Clear & Bright
Point de congélation °C Freeze Point, °C	-60 max.
Pression de vapeur Reid, kPa Vapour Pressure, Reid, kPa	38-48
Distillation, A.S.T.M.	
10% évaporé - evaporated, °C	75 max.
50% évaporé - evaporated, °C	105 max.
90% évaporé - evaporated, °C	135 max.
P.F.-E.P., °C	170 max.
Teneur en plomb, g/L Lead content, g/L	1,12 max.
Gomme préformée, mg/100 ml Existent gum, mg/100ml	3,0 max.

Ce produit est conforme à l'O.N.G.C. CAN 2-3.25-M77 Grade 100.
The above product meets C.G.S.B. CAN 2-3.25-M77 Grade 100.

J. Sofia
Le Conseiller - cadre technique
Staff Technical Advisor

Date: 82/03

SHELL CANADA LIMITÉE/LIMITED

RÉGION COMMERCIALE DE L'EST — EASTERN MARKETING REGION

Distillat - Climat Nordique Shell

Shell Northern Distillate

Essais - Characteristics	Specifications
Densité @ 15°C, Kg/L Gravity, @ 15°C, Kg/L	--------
Couleur, ASTM Colour, ASTM	2,0 max.
Point Éclair, P.M.C.C. °C Flash Point, P.M.C.C. °C	40 min.
Corrosion à la lame de cuivre, 3 hrs @ 50°C Corrosion, Cu. Strip., 3hr. at 50°C	No. 1 max.
Soufre % à la masse Sulphur, % by mass	0,2 max.
Point d'Écoulement °C Pour Point, °C	-45 max.
Indice de cétane calculé Cetane Index, calculated	45 min.
Résidu de Carbone, Rams % à la masse Carbon Residue, Ramsbottom, on 10% bottoms % b.mass.	0,1 max.
Distillation, A.S.T.M.	
10% récupéré °C/recovered °C	---
50% récupéré °C/recovered °C	---
90% récupéré °C/recovered, °C	290 max.
Point Final °C - E.P., °C	300 max.
Viscosité @ 40°C, mm^2/S Viscosity @ 40°C, mm^2/S	1,2 min.
Centres, %à la masse Ash, %/mass.	0,005 max.
Eau et sédiment % vol. Water and sediment % by vol.	0,01 max.

Ce produit est conforme à l'O.N.G.C. CAN 2-3.2-M81 Type 00 (Sauf pour le point d'écoulement)
The above product meets C.G.S.B. CAN 2-3.2-M81 Type 00 (Except for pour point)

J. Sofia
Le Conseiller - cadre technique
Staff Technical Advisor

Date: 82/03

SHELL CANADA LIMITÉE/LIMITED

RÉGION COMMERCIALE DE L'EST — EASTERN MARKETING REGION

Carburéacteur Shell A-1

Shell Jet A-1

Essais - Characteristics	Specifications
Densité @ 15°C, Kg/L Gravity @ 15°C Kg/L	0,774 - 0,839
Couleur, Saybolt Colour, Saybolt	+12 min.
Point Éclair, Tag Vase clos °C Flash Point, Tag CC., °C	38 min.
Odeur Odour	Acceptable
Corrosion à la lame de cuivre, 2 hrs @ 100°C Corrosion, Cu. Strip., 2 hr. at 100°C	No. 1 max.
Soufre Mercaptan % à la masse Mercaptan Sulphur, % by mass	0,003 max.
Apparence Appearance	Limpide Clear
Point de congélation °C Freezing Point, °C	-47 max.
Distillation, A.S.T.M.	
10% récupéré - recovered °C	204 max.
50% récupéré - recovered °C	232 max.
Point Final °C - E.P., °C	300 max.

Ce produit est conforme à l'O.N.G.C. CAN 2-3.23-M80 Grade JET A-1
The above product meets C.G.S.B. CAN 2-3.23-M80 Grade JET A-1

J. Sofia
Le Conseiller - cadre technique
Staff Technical Advisor

Date: 82/03

SHELL CANADA LIMITÉE/LIMITED

RÉGION COMMERCIALE DE L'EST — EASTERN MARKETING REGION

Essence Shell Régulière

Shell Regular Gasoline

Essais - Characteristics	Specifications Été/Summer	Hiver/Winter
Couleur Color	Ambre Amber	Ambre Amber
Indice d'octane (F-1) Octane No. (F-1)	92,0 min.	91,4 min.
Indice d'octane $\frac{(R+3M)}{4}$ Octane No. $\frac{(R+3M)}{4}$	87,5 min.	86,9 min.
Contenu en plomb mg/L Lead Content mg/L	,77 max.	,77 max.
Soufre % à la masse Sulphur, % by mass	0,15 max.	0,15 max.
Période d'induction, h. Induction period, h.	4 min.	4 min.
Gomme préformée, mg/100 ml Existent gum, mg/100ml	5 max.	5 max.
Corrosion à la lame de cuivre Corrosion, Cu. Strip 3 h @ 50°C	No. 1 max.	No. 1 max.
Point de congélation °C Freezing Point, °C	-51 max.	-51 max.
Distillation, A.S.T.M.		
10% évaporé °C - evaporated, °C	57 max.	52 max.
50% évaporé °C - evaporated, °C	118 max.	113 max.
90% évaporé °C - evaporated, °C	185 max.	185 max.
Point Final °C - E.P., °C	218 max.	218 max.
Pression de vapeur Reid, KPa Vapour Pressure Reid, KPa	59 - 75	86 - 103

Ce produit est conforme à l'O.N.G.C. CAN 2-3.1-M78 Type 2
The above product meets C.G.S.B. CAN 2-3.1-M78 Type 2

J. Sofia
Le Conseiller - cadre technique
Staff Technical Advisor

Date: 82/03

ANNEX B TO APPENDIX B

SHQ HOUSE OCCUPANTS

MUNICIPAL HOUSING CORPORATION - KUUJJUAQ - from SHQ Files (1983)

TENANT	HSE NO
ABRAHAM, Nora	225
ADAMS, Charlie	211
ADAMS, Eva	194
ADAMS, Johnny Jr.	185
ADAMS, Johnny Sr.	205
ADAMS, Penina	182
ADAMS, Peter	144
ADAMS, Spike	140
ADAMS, Willie	222
ANDERSEN, Tom	206
ANGNATUK, Betsy	90
ANGNATUK, Elijah	188
ANGNATUK, Jimmy	241-B
ANGNATUK, Johnny	212
ANGNATUK, Kenny	143
ANGNATUK, Noah	199
ANGNATUK, Sammy Ch.	27
ANGNATUK, Sammy Mox	223
ANGNATUK, Sandy	145
ANGNATUK, Tamu	150
ANGNATUK, Tommy	169
ANNANACK, Annie	192
ANNANACK, Elijah	191
ANNANACK, Sammy	172
BERTHE, Alice	126
BERTHE, Lizzie	26
BERTHE, Louisa	201
BERTHE, Simeonie	129
BERENDES, Ingo	164
CAIN, Vallee	236-A
CLUNAS, Neil	118
COOPER, Sammy	132
COOPER, Tommy	120
COOPER, Willie	240-A
DUMONT, Michel	187
DUNCAN, Annie	178
ELIJAPIC, Mark	218
GADBOIS, Claude	238-B
GORDON, Alec C.	183
GORDON, Annie	122
GORDON, Charlie Jr.	168
GORDON, Charlie Sr.	228
GORDON, Christina	173
GORDON, Johnny	196
GORDON, Maggie	202
GORDON, Norman	121
GORDON, Sandy Jr.	200
GORDON, Sandy Sr.	238-A
GORDON, Toma	209
GORDON, Tommy	232
GORDON, Vallee	219
GREY, Christina	165
HUBLOO, Conlucy	157
HUBLOO, Norman	123
JOHANNES, Elijah	24
JOHANNES, George	177
JOHANNES, Jimmy	147
JOHANNES, Tommy	174
JONAS, Peter	241-A
KAUKI, Mary	163
KLEIST, Tikili	216
KOKKINERK, Elijah	229
KOOKTOOK, Tommy	231
KOTAK, Mary	106
KRITIK, Peter	131
KONEAK, David	151

TENANT	HSE NO
KONEAK, Edward	235
KONEAK, George	240-B
KONEAK, Jackie	119
KONEAK, Moses	159
KONEAK, Sarah	158
KUDLUK, Charlie	160
KUDLUK, Poasie	207
LEMIERE, Michel	221
LEPAGE, Paul	170
MAY, Billy	234
MAY, Johnny	210
MAKIUK, Charlie	175
MAKIUK, Pasha	179
MESHER, Chesley	76
MESHER, Victor	226
MUNICK, Johnny	237-A
MUNICK, Martha	184
NINGIURUVIK, Charlie	146
NIKKI, Mary	230
OKUATSIAK, Charlie	198
PAPAK, Charlie	197
PAPAK, Elizabeth	193
PARTRIDGE, George	100
PARTRIDGE, Lucas	190
PARTRIDGE, Moses	111
PARTRIDGE, Peter	148
PARTRIDGE, Willie	189
ROBERTSON, Ian D.	166
RUSTON, Harriet	214
SAUNDERS, Charlie	128
SAUNDERS, David	105
SAUNDERS, Harry	155
SAUNDERS, Jimmy	136

TENANT	HSE NO
SAUNDERS, Jobie	127
SAUNDERS, Peter Jr.	181
SAUNDERS, Peter Sr.	237-B
SAUNDERS, Sammy	227
SAUNDERS, Sandy N.	203
SAUNDERS, Sandy Sr.	195
SAUNDERS, Tommy Jr.	213
SAUNDERS, Tommy Jr.Jr	180
SAUNDERS, Tommy Sr.	176
SAUNDERS, Vallee E.	130
SAUNDERS, Vallee J.	134
SEQUALUK, Poasie	152
SEQUALUK, Sarah	217
SEQUALUK, Sinassie	154
SEQUALUK, Tommy	153
SHENNUNGNUK, Alice	137
SHENNUNGNUK, Maggie	142
SHIPALUK, Elijah	167
SHIPALUK, Ned	171
SNOWBALL, Bobby Jr.	124
SNOWBALL, Bobby Sr.	215
SNOWBALL, Conlucy	156
SNOWBALL, Dorothy	125
SNOWBALL, Jobieapic	135
SNOWBALL, Mary	138
SUPPA, David	110
SUPPA, Penina	141
SUPPA, Peter Jr.	162
SUPPA, Peter Sr.	149
SUPPA, Mark	161
TASSE, Jessie	186
TOOMA, Joe	236-B
TUKKIAPIK, Elijah	23

TENANT	HSE NO
TUKKIAPIK, Elizabeth	204
TUKKIAPIK, Minnie	133
TUKKIAPIK, Sammy	220
WATT, Charlie	301
WATT, Daisy	303
WATT, Elijah	239-B
WATT, Johnny	302
WHITE, Mae	25
WHITE, Victor	139
York, Alan	208

MUNICIPAL HOUSING CORPORATION - KANGIRSUK - from SHQ Files (1982)

TENANT	HSE NO
Nassak, Joseph	101
Grey, Elijah	102
Carrier, Lucy	103
Grey, Peter	104
Annahatak, Lolly	105
Yeats, Mark &	106
Annahatak, Jimmy	106
Keleutak, Elizabeth	107
Nassak, Angnatuk	108
Willie, Tomasie	109
Airo, M. Peter	110
Koovalook, Peter	111
Grey, Annie	112
Kudluk, Jonas	113
Tukkiapik, Dallacy	114
Simigak, Eyesiak	115
Adlook, Mary	116
Nassak, Peter	117
Kudluk, Sammy	118
Nassak, Sammy	119
Augiak, Aggie	120
Kudluk, Annie	121
Kudluk, Taka	122
Ogvik, Kitty	123
Kudluk, Tomassie	124
Annahatak, George	125
Eetook, Annie	126
Airo, Johnny	127
Gillespie, David	128
Annahatak, Charlie	129

TENANT	HSE NO
Eetook, Aloupa	131
Airo, T. Peter	132
Pootoogee, David	133
Nungak, Zebedee	134
Pingwapik, David	135
Lucassie, Lizzie	136
Kotak, Tommy	137
Tomassie, Thomas	138
Augiak, Thomas	139
Tomassie, Adamie	140
Airo, Sarah	141
Grey, Jessie	142
Kauki, George	143
Eetook, Markus	144
Kauki, Tommy	145
Annahatak, Sam W	146
Annahatak, Minnie	147
Simunie, Simunie	105*
	126**
	129***

* Sept-December occupant

** Nov-December - empty

*** Nov-December - moved, replaced by Eetook, Annie

ANNEX C TO APPENDIX B

REMOTE LOW ENERGY HOUSING DEMONSTRATION*

NEW HOUSE - HEAT LOSS ANALYSIS

A heat loss analysis using the Hotcan computer program developed by NRC and available at Energy, Mines and Resources was carried out. This analysis predicts the annual fuel costs. based on the following inputs:

Area of each building element(walls,windows,ceiling,etc.)
Insulation valve of each building element
Temperature of living areas
Number of people living in building
Daily electrical and water consumption
Mass of building
Shading of windows
Infiltration rate
Ventilation air rate and efficiency of heat exchange.

By varying the insulation valve of each building element (eg walls) and comparing the differences in heating costs with the differences in the capital cost to build each element, keeping everything else constant, we can determine the cost effectiveness and payback for building each element with various insulation levels.

The capital cost vs. insulation valve of the element(eg wall systems) gives a roughly linear relationship, that is for every incremental increase in insulation value the capital cost goes up in proportion. This assumes that you actually choose to use standard sizes of insulation batts and lumber dimensions. For example for the ceiling insulation for each additional unit of R, the roof cost goes up $11.20. See graph 1.

For annual fuel costs vs. insulation value, the relationship is a decreasing curve which flattens out at higher R value. See graph 2.

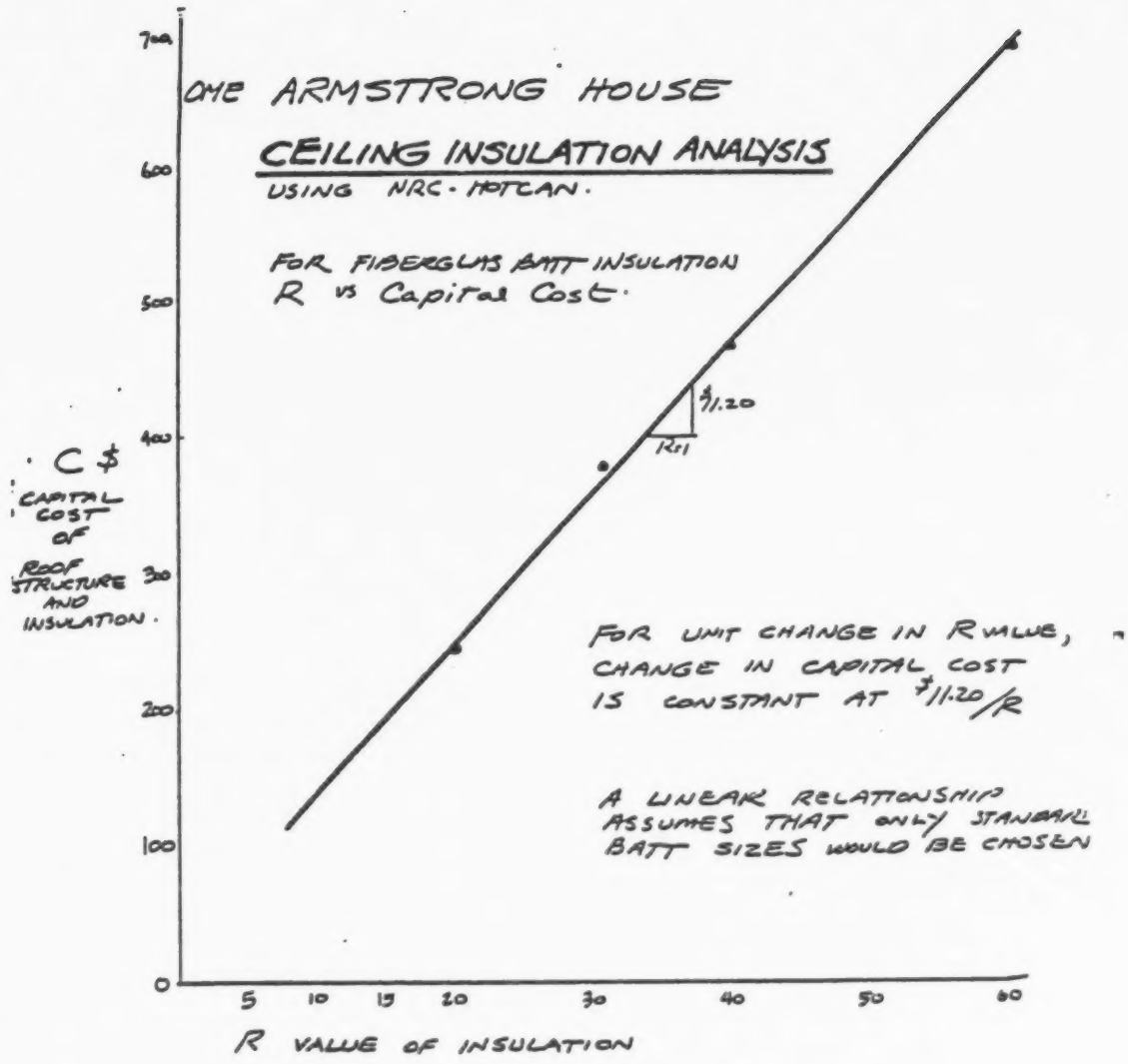
The simple payback in money spent to increase the insulation value is:

$$\text{Payback} = \frac{\text{added capital spent in insulation}}{\text{fuel saved}} = \frac{\Delta\$/R}{\text{slope of curve}/R}$$

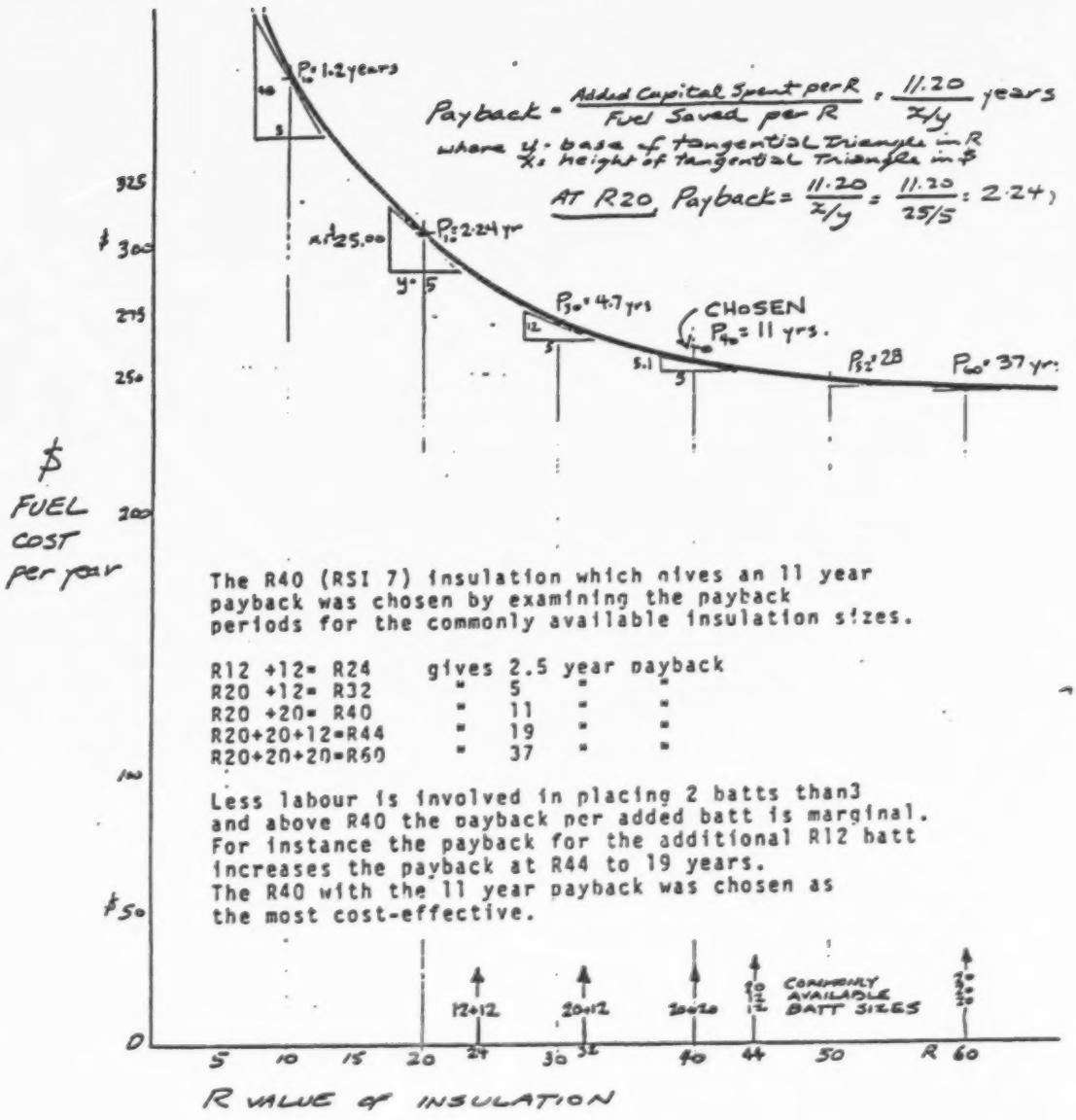
Which is for ceiling insulation; $p = \frac{11.20}{x/y} = \frac{11.20}{25/5} = 2.24$ years

This is a value for the marginal payback, that is to say the payback if you increase the insulation value by R=1 at that particular value for R.

* Prepared by Shelter Construction and Development Limited for the Ontario Ministry of Energy, Project 399-8520, Phase I Report, February 23, 1984.


ONE ARMSTRONG HOUSE
CEILING INSULATION ANALYSIS
USING NRC - HOTCAN.
FOR FIBERGLAS BATT INSULATION
R vs Capital Cost.
$11.20
1R=1
C $
CAPITAL COST OF ROOF STRUCTURE AND INSULATION.
FOR UNIT CHANGE IN R VALUE, CHANGE IN CAPITAL COST IS CONSTANT AT $11.20/R
A LINEAR RELATIONSHIP ASSUMES THAT ONLY STANDARD BATT SIZES WOULD BE CHOSEN
700
600
500
400
300
200
100
0
5
10
15
20
30
40
50
60
R VALUE OF INSULATION

GRAPH # 1

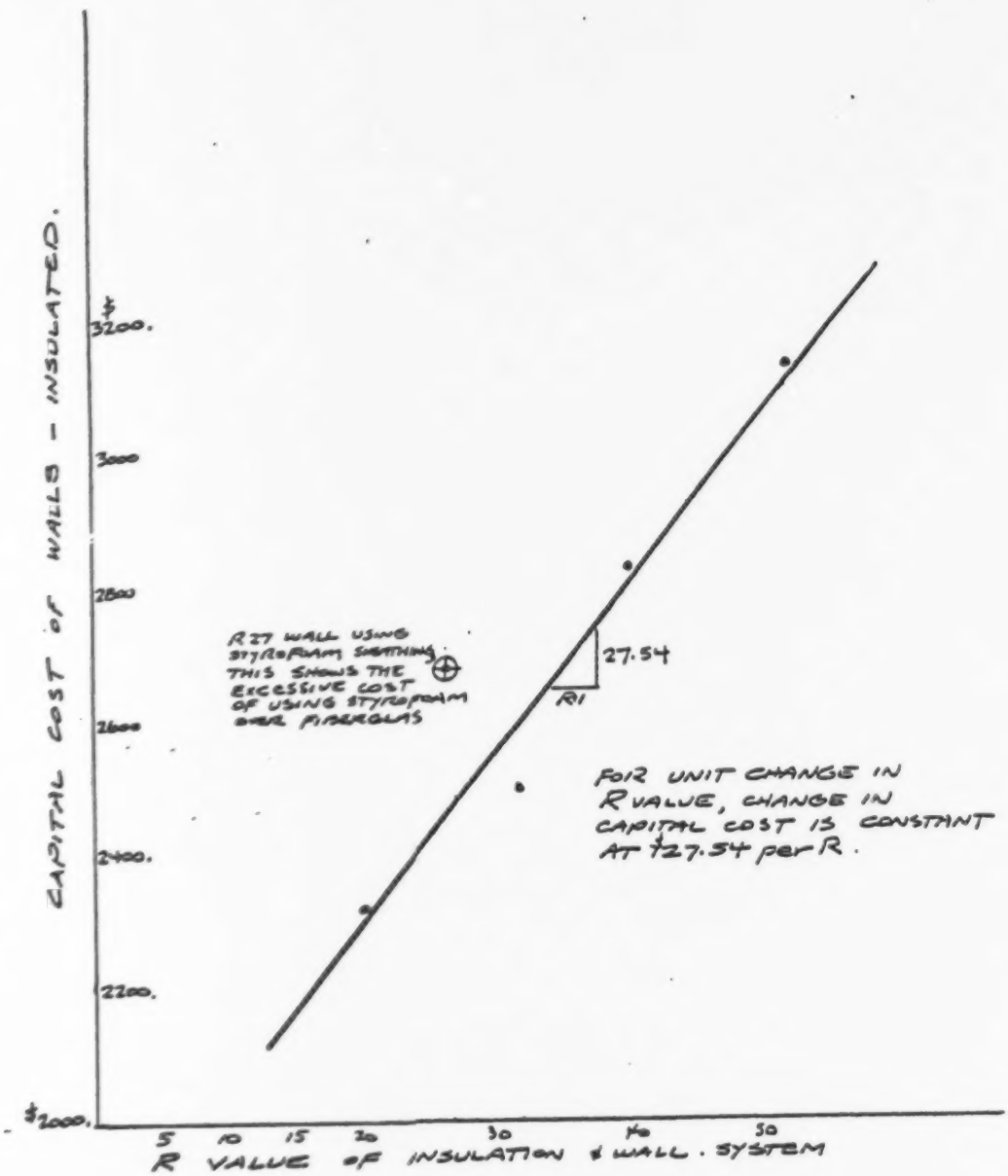


The R40 (RSI 7) insulation which gives an 11 year payback was chosen by examining the payback periods for the commonly available insulation sizes.

R12 +12= R24	gives	2.5	year	payback
R20 +12= R32	"	5	"	"
R20 +20= R40	"	11	"	"
R20+20+12=R44	"	19	"	"
R20+20+20=R60	"	37	"	"

Less labour is involved in placing 2 batts than3 and above R40 the payback per added batt is marginal. For instance the payback for the additional R12 batt increases the payback at R44 to 19 years. The R40 with the 11 year payback was chosen as the most cost-effective.

OME ARMSTRONG HOUSE
CEILING INSULATION ANALYSIS - NRC HOTCAP
USING FIBERGLAS BATT INSULATION
R vs Fuel Cost per Year. GRAPH #2



OME ARMSTRONG HOUSE

WALL INSULATION ANALYSIS USING NRC HOTCAN

USING FIBERGLAS BATT INSULATION

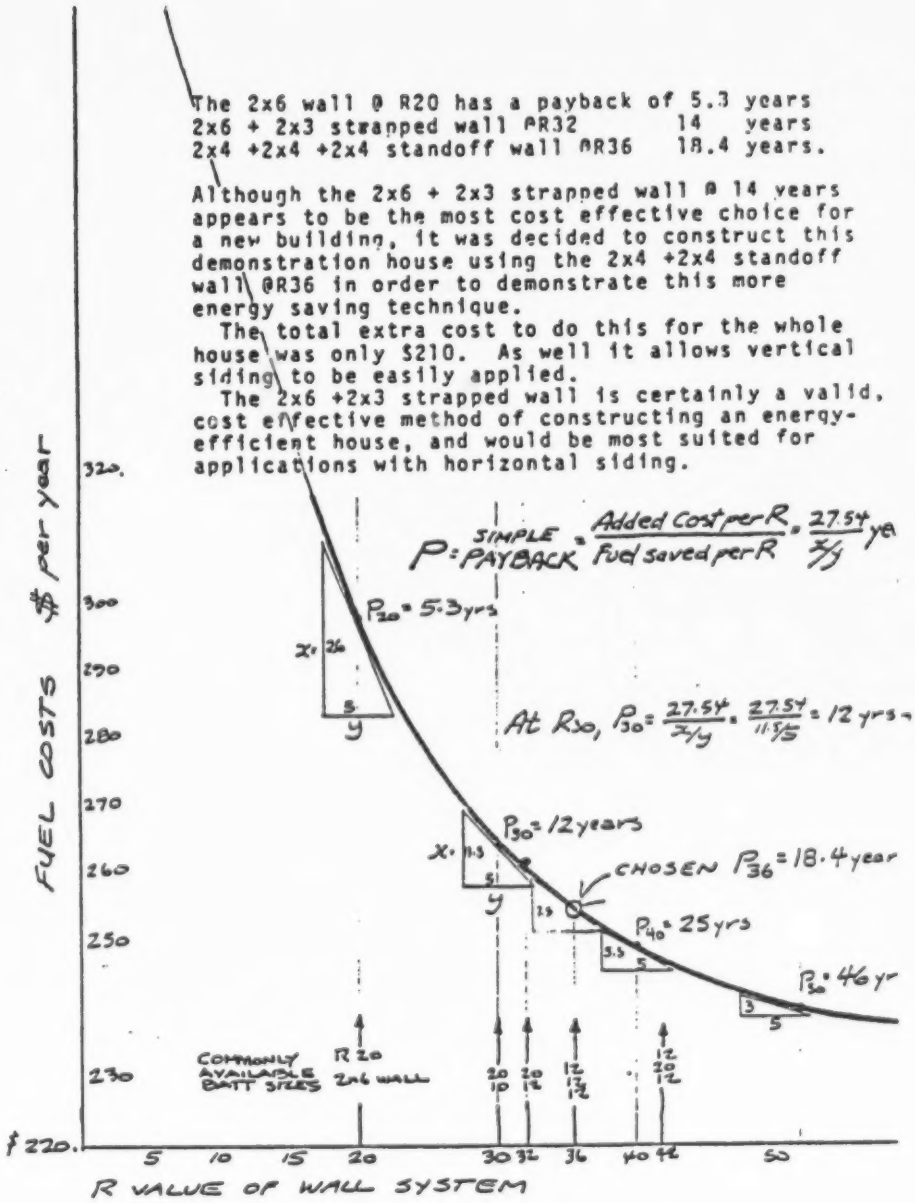
R VS CAPITAL COST OF WALL.

The 2x6 wall @ R20 has a payback of 5.3 years
2x6 + 2x3 strapped wall @R32 14 years
2x4 +2x4 +2x4 standoff wall @R36 18.4 years.

Although the 2x6 + 2x3 strapped wall @ 14 years appears to be the most cost effective choice for a new building, it was decided to construct this demonstration house using the 2x4 +2x4 standoff wall @R36 in order to demonstrate this more energy saving technique.

The total extra cost to do this for the whole house was only $210. As well it allows vertical siding to be easily applied.

The 2x6 +2x3 strapped wall is certainly a valid, cost effective method of constructing an energy-efficient house, and would be most suited for applications with horizontal siding.



OME - ARMSTRONG HOUSE
WALL INSULATION ANALYSIS USING NRC HOTCAN
WITH FIBERGLAS BATT INSULATION
R vs Fuel Costs per year.

ANNEX D TO APPENDIX B

CLIMATE DATA

CHARTS OF MEAN DAILY GLOBAL SOLAR RADIATION
DIAGRAMMES DES MOYENNES DU RAYONNEMENT SOLAIRE GLOBAL JOURNALIER

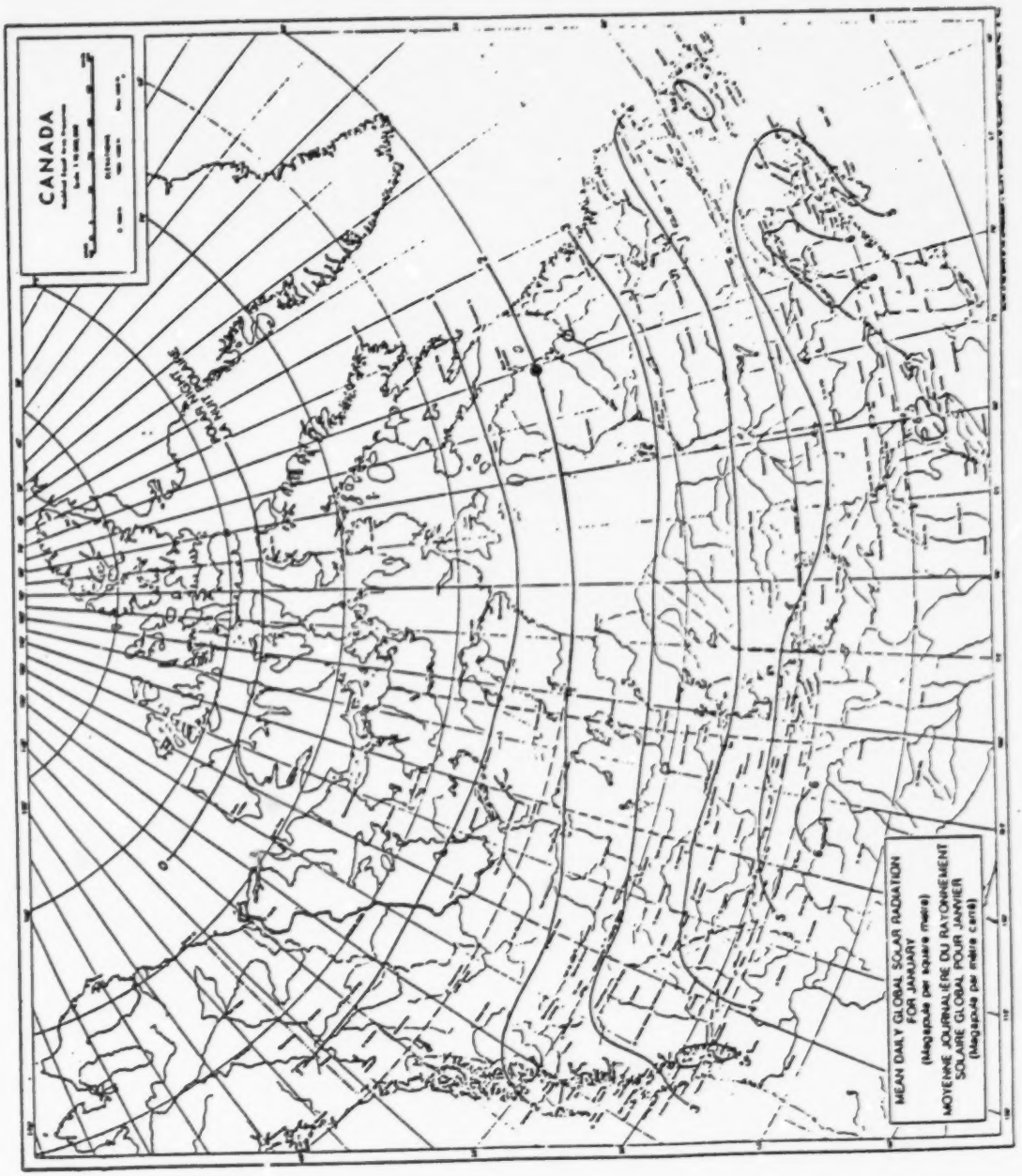
Charts/Tableaux

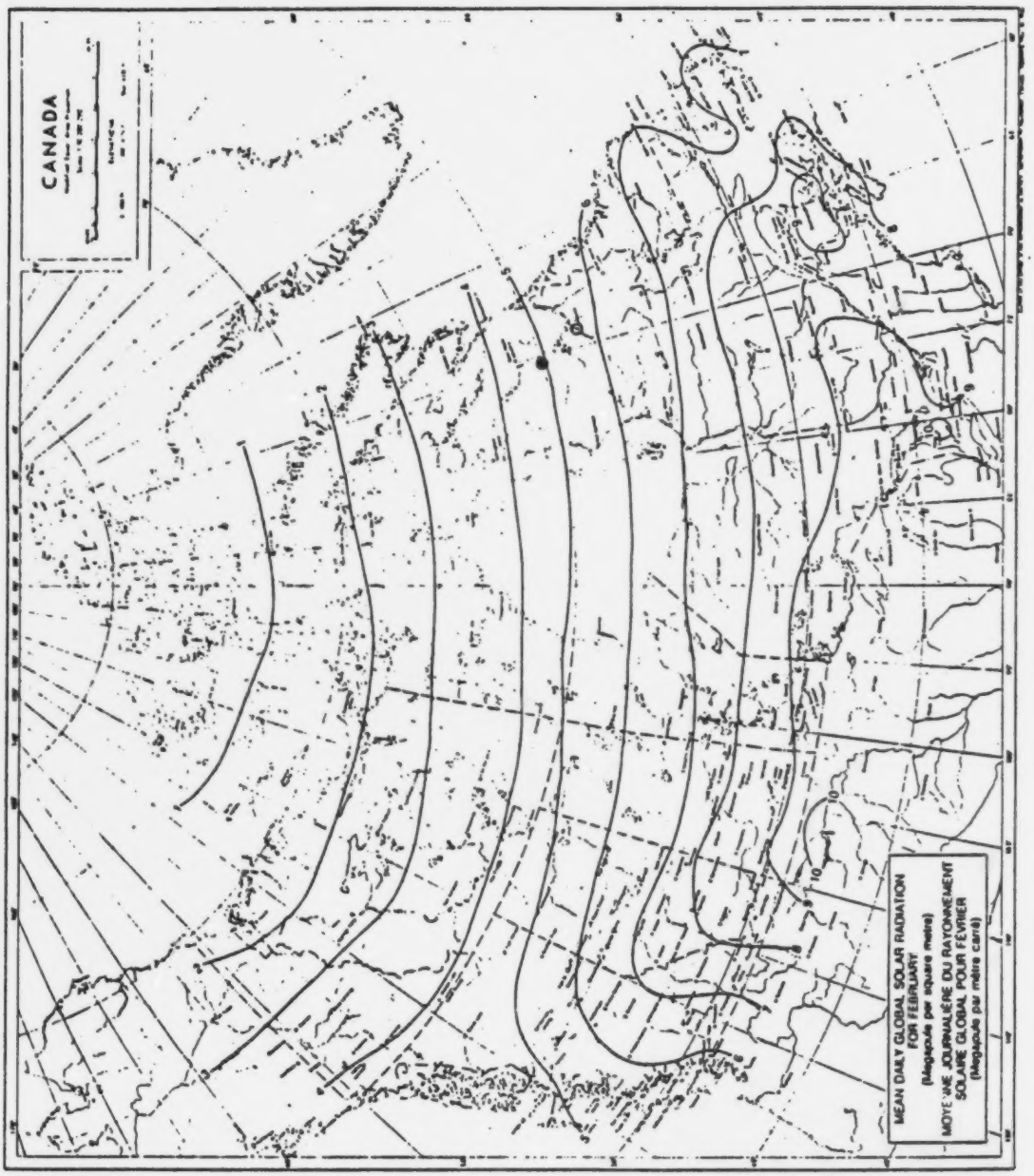
1-12	January to December janvier à décembre
13	Annual Annuel

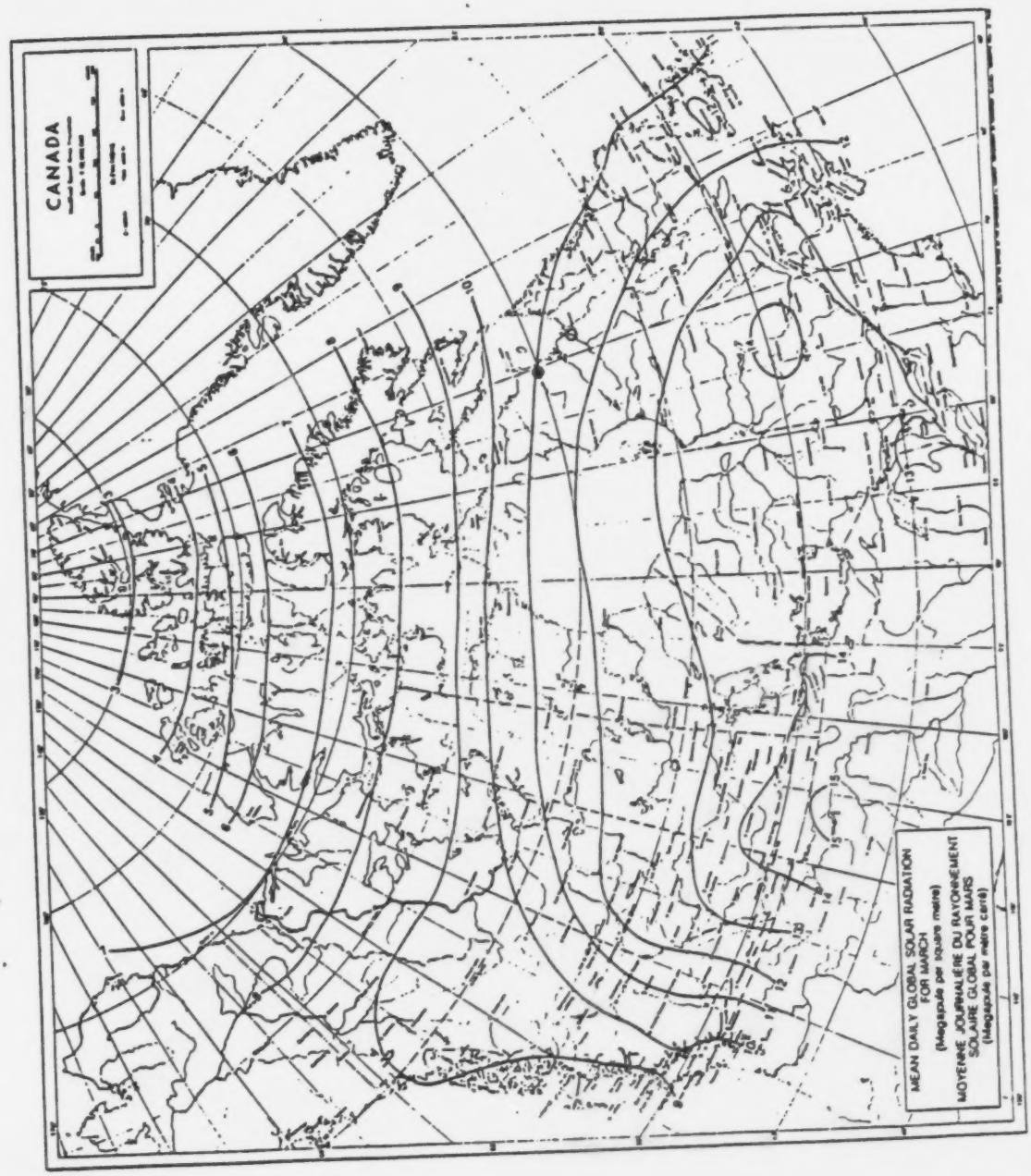
On the charts on the following pages,

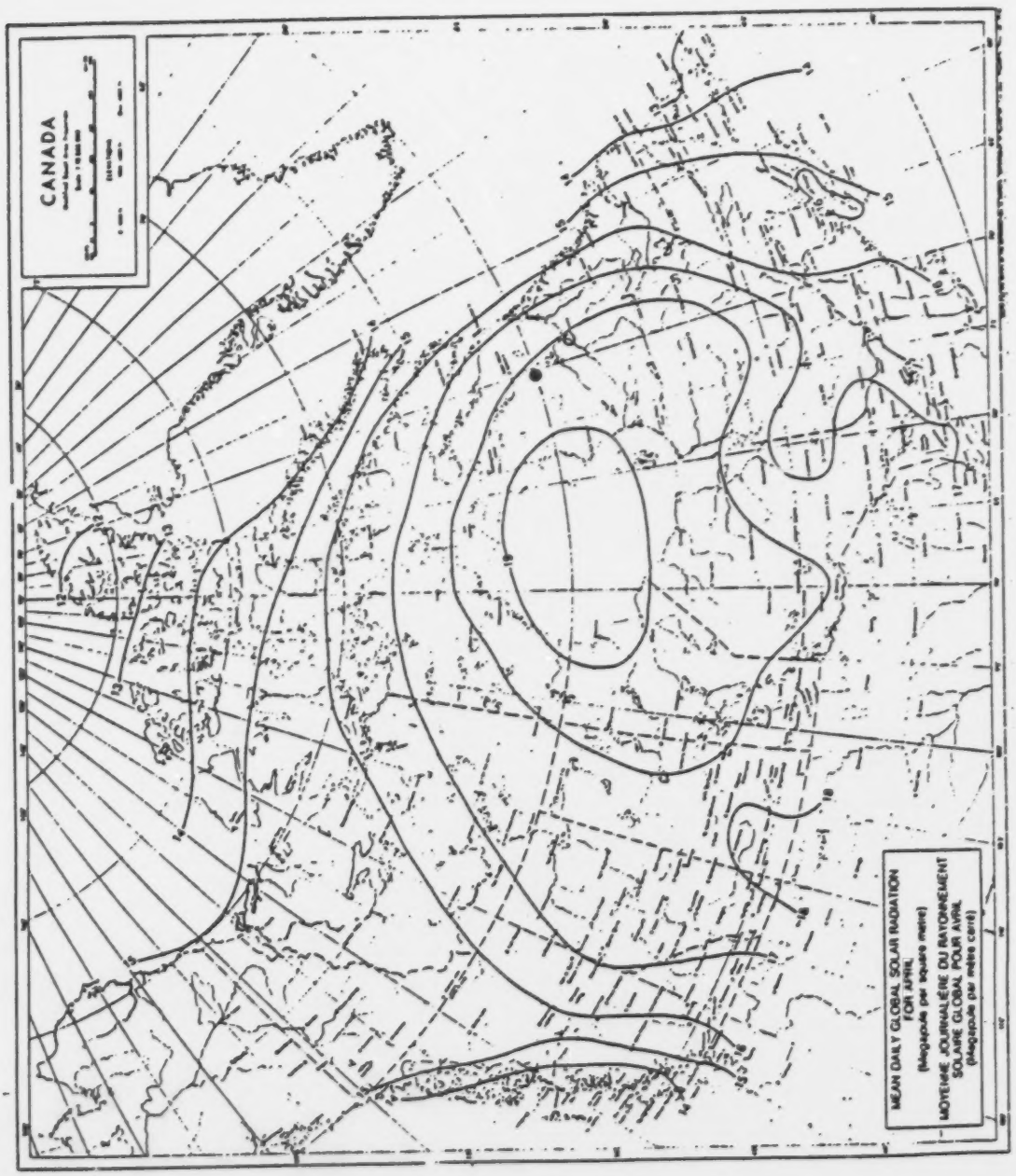
Kangirsuk is represented by the symbol ●

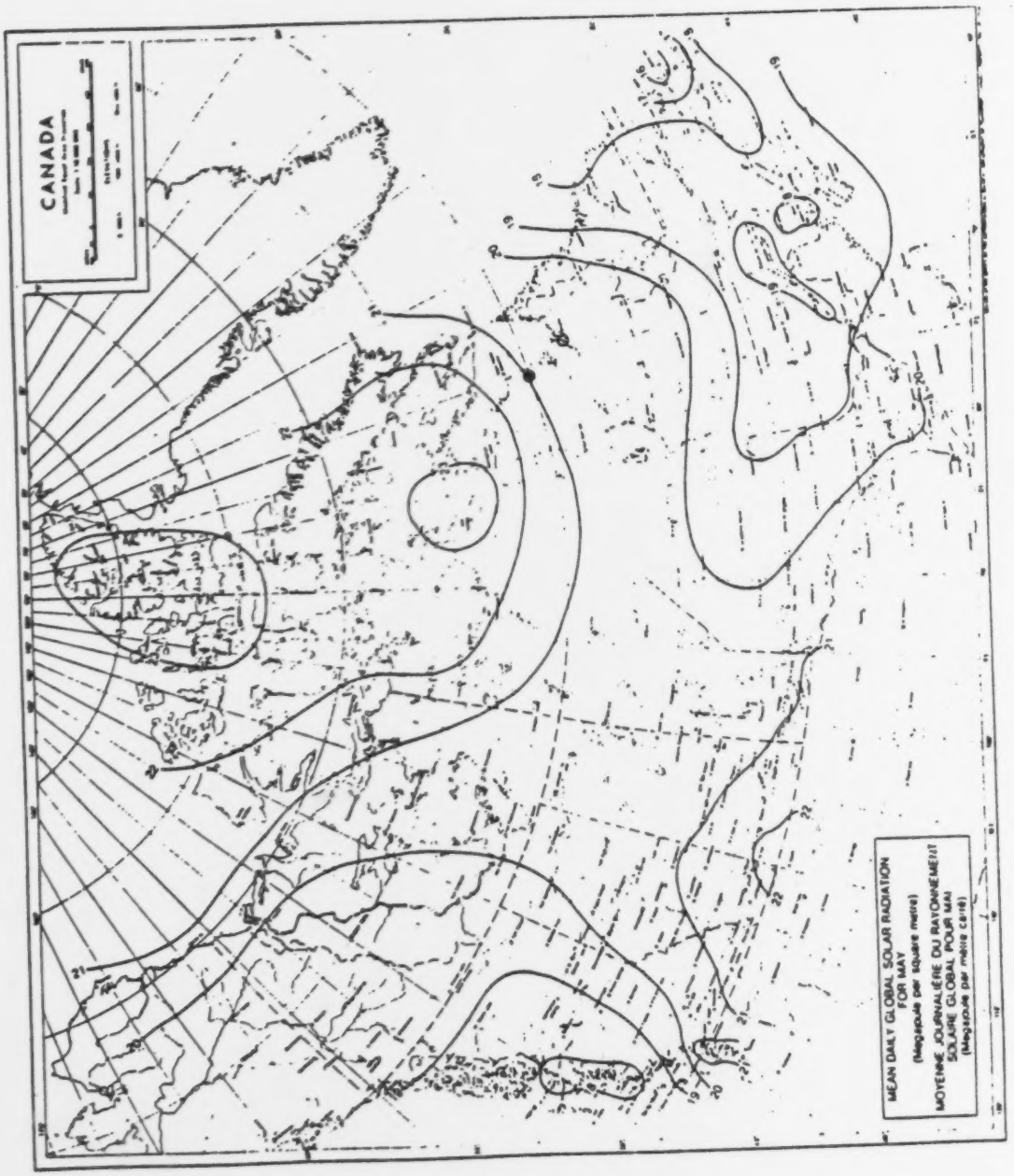
Kuujjuaq is represented by the symbol o

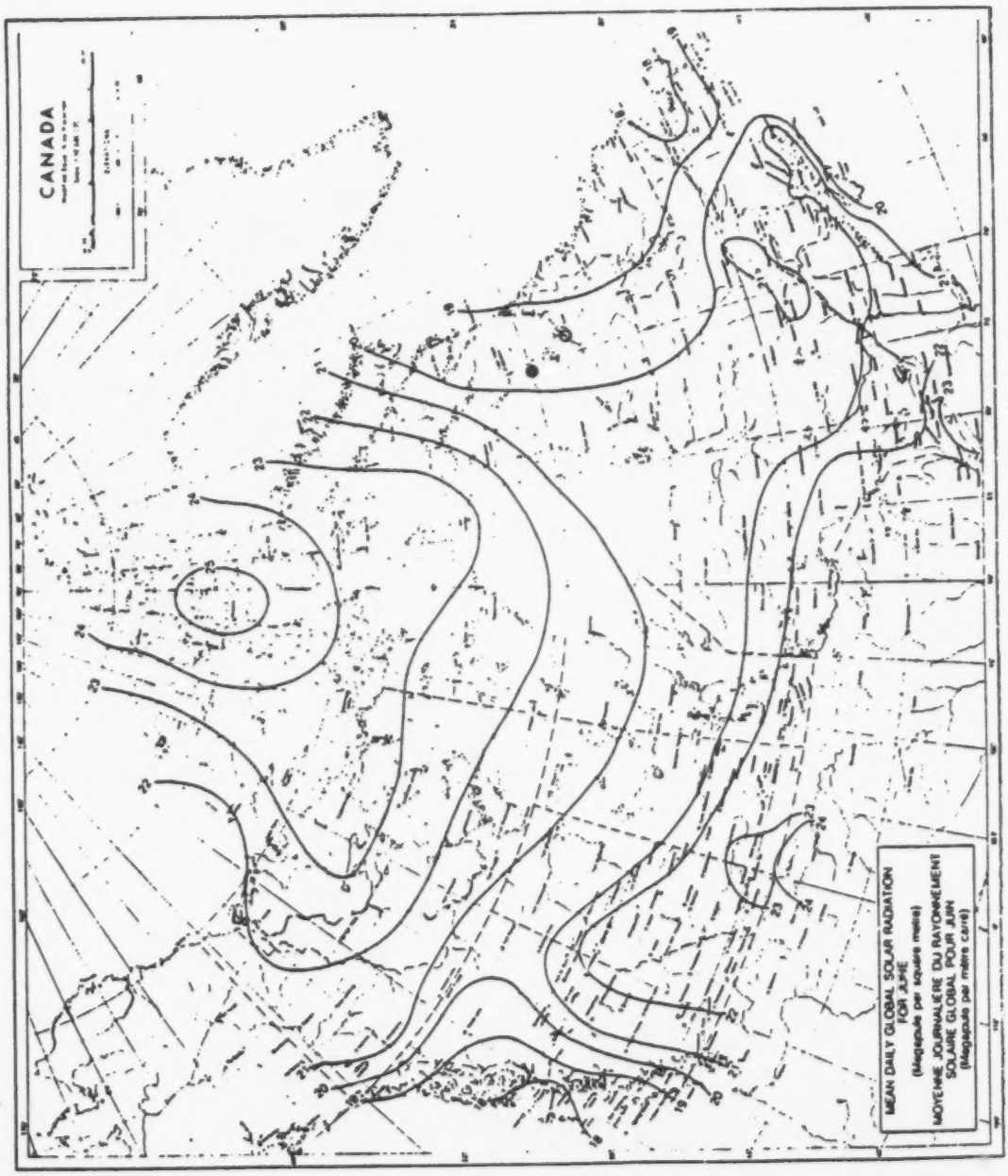

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION
FOR JANUARY
MOYENNE JOURNALIÈRE DU RAYONNEMENT
SOLAIRE GLOBAL POUR JANVIER

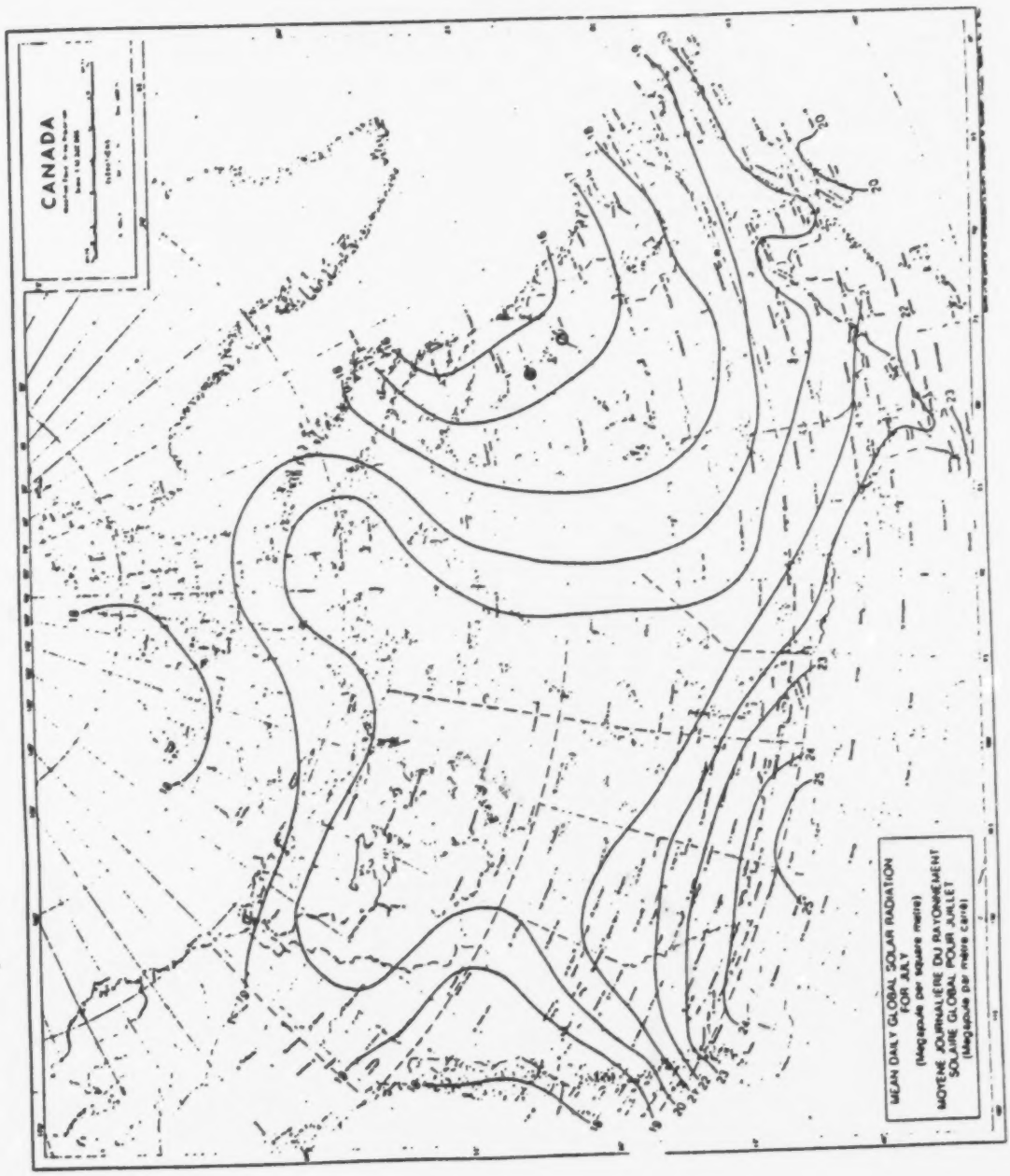

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION
FOR FEBRUARY
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT
SOLAIRE GLOBAL POUR FÉVRIER
(Megajoule par mètre carré)

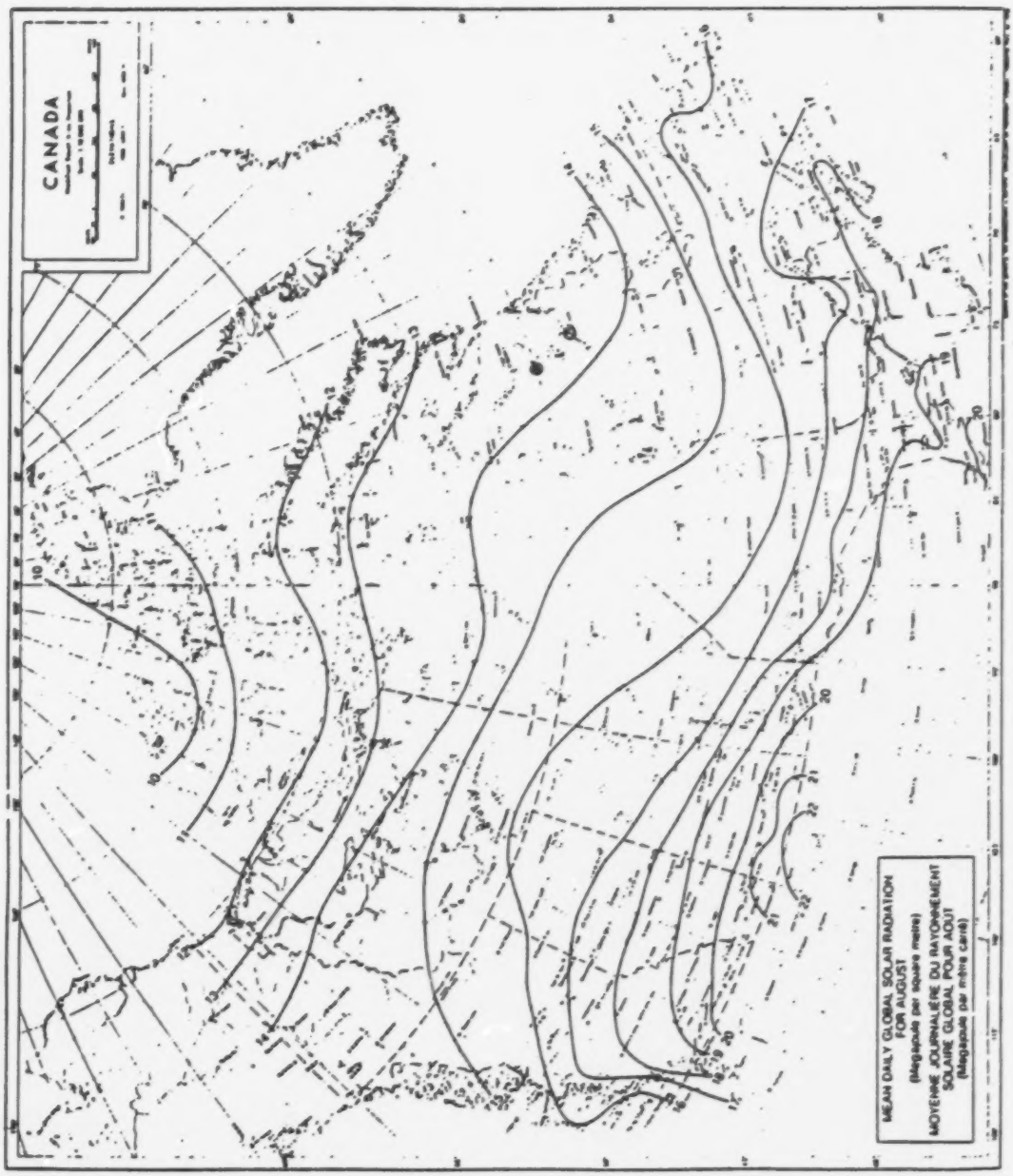

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION
FOR MARCH
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT
SOLAIRE GLOBAL POUR MARS
(Mégajoule par mètre carré)

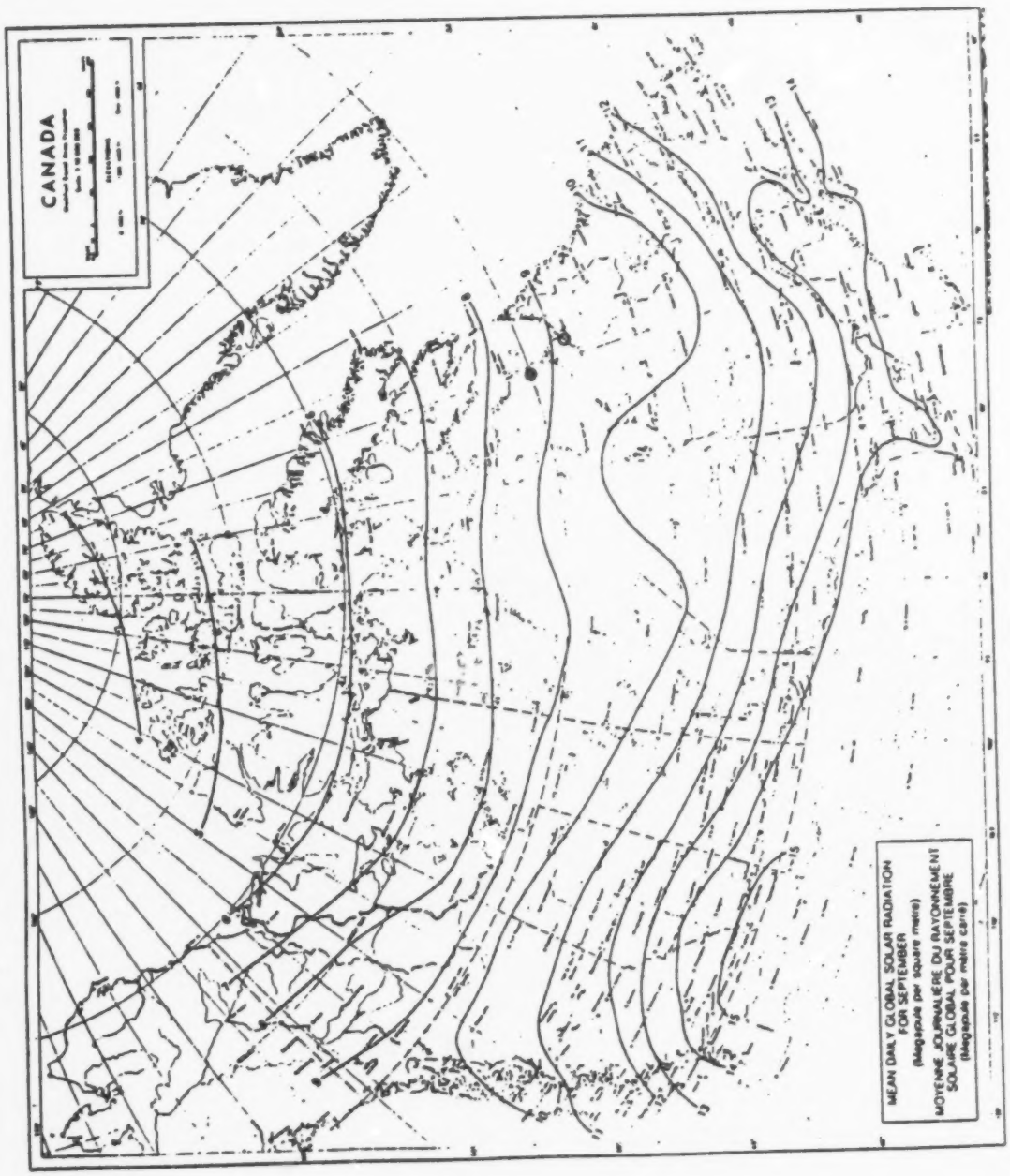

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION
FOR APRIL
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT
SOLAIRE GLOBAL POUR AVRIL
(Mégajoule par mètre carré)

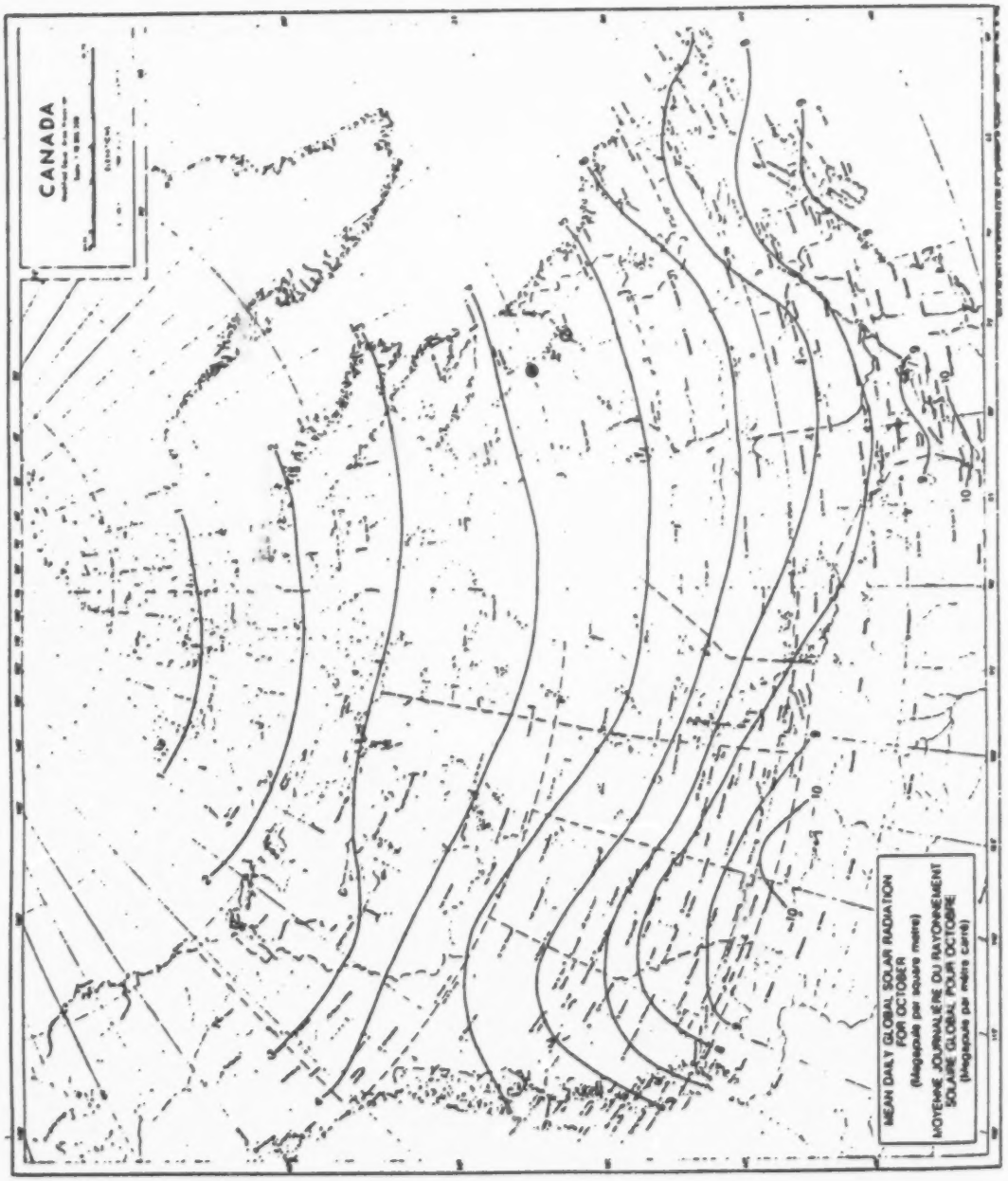

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION
FOR MAY
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT
SOLAIRE GLOBAL POUR MAI
(Mégajoule par mètre carré)

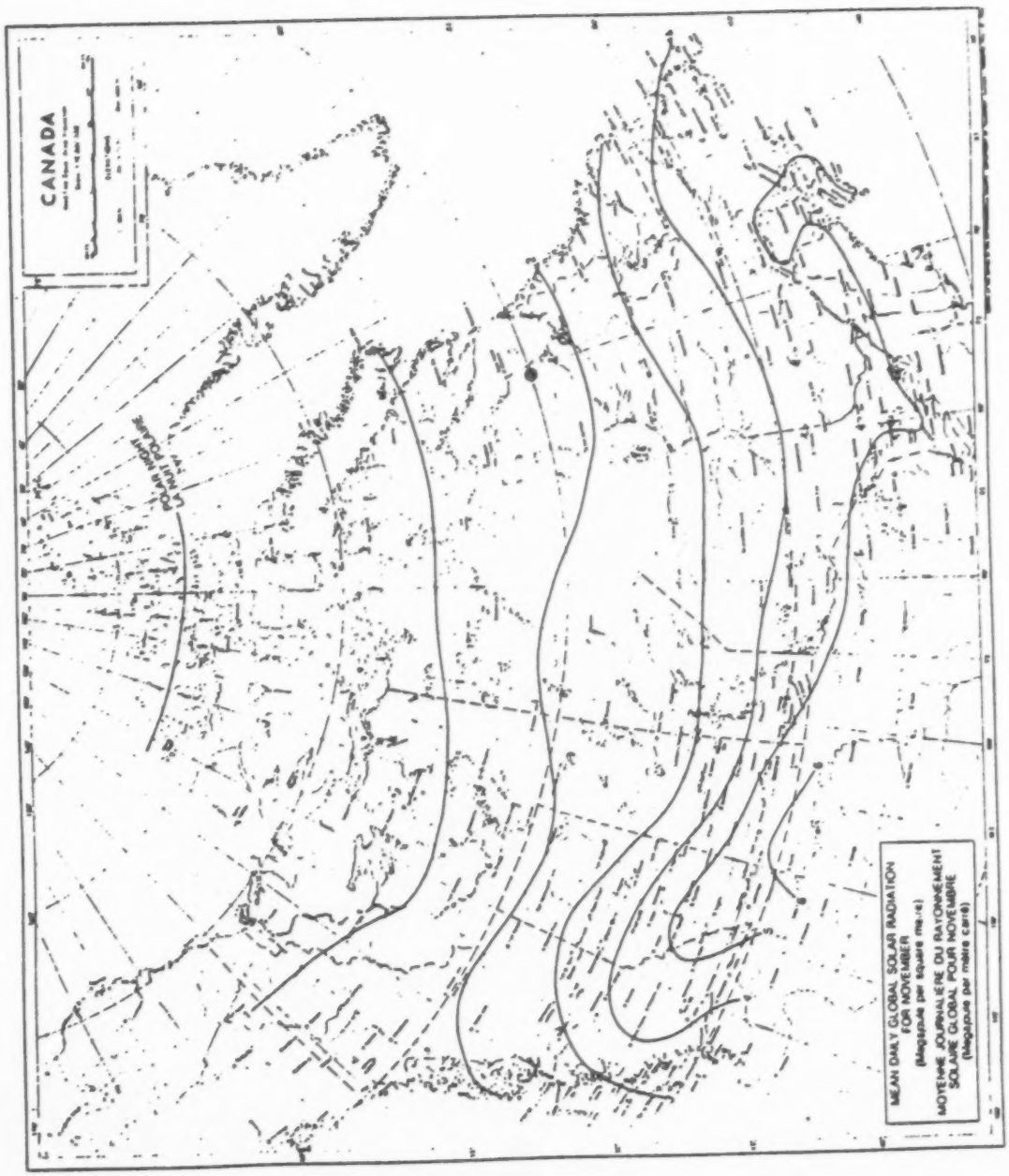

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION FOR JUNE
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT SOLAIRE GLOBAL POUR JUIN
(Megajoule par mètre carré)

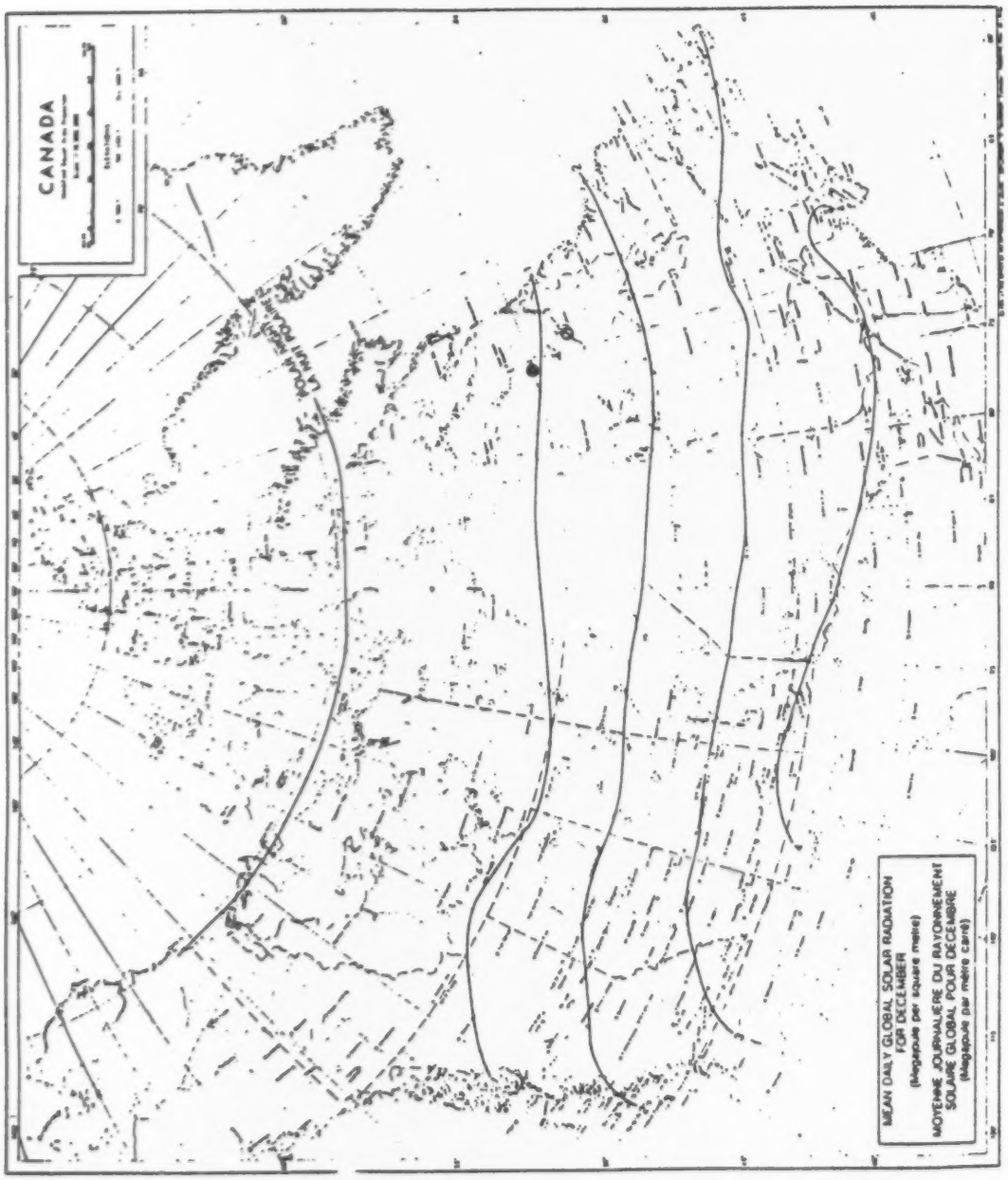

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION FOR JULY
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT SOLAIRE GLOBAL POUR JUILLET
(Mégajoule par mètre carré)

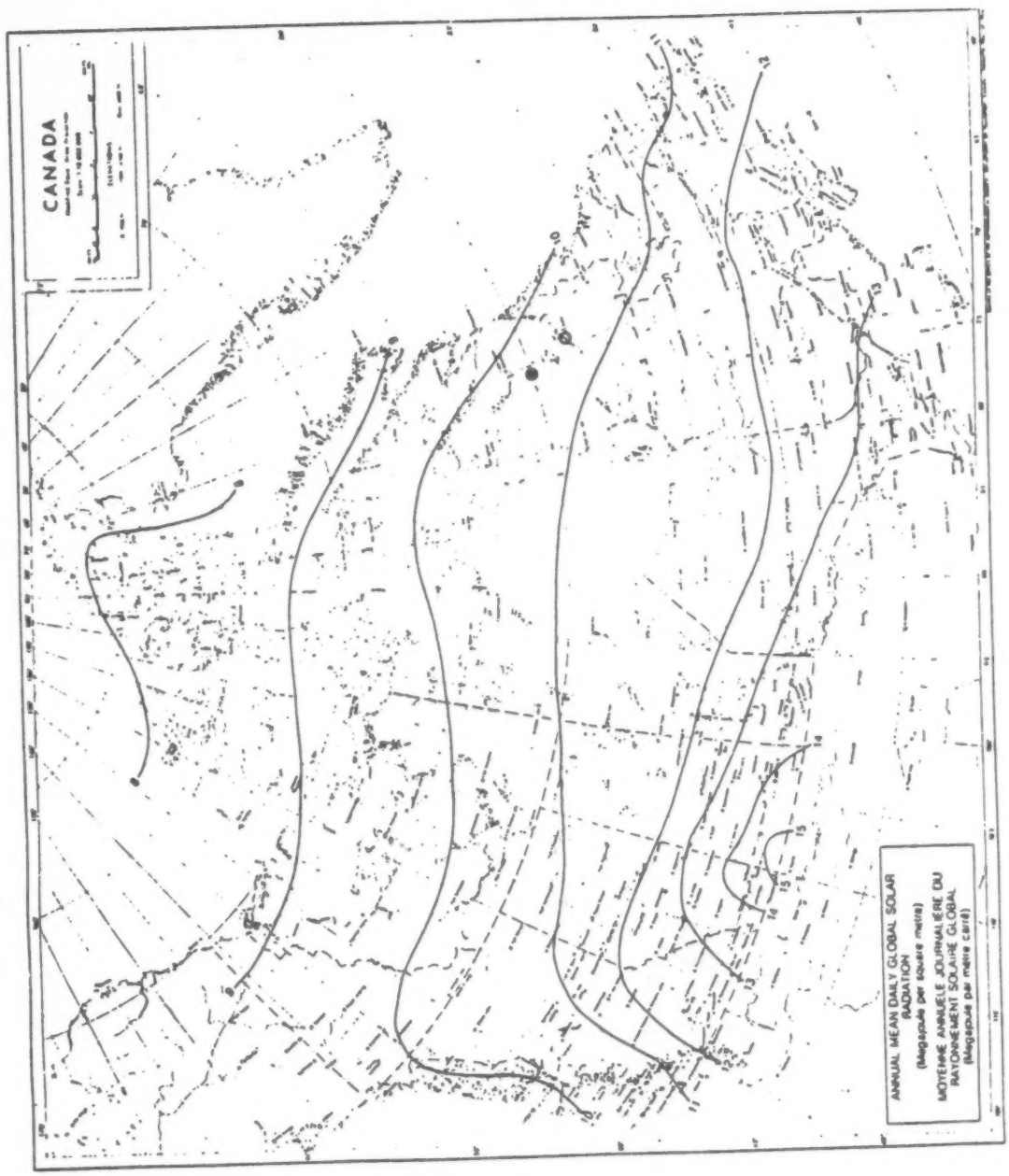

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION FOR AUGUST
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT SOLAIRE GLOBAL POUR AOÛT
(Mégajoule par mètre carré)


CANADA
MEAN DAILY GLOBAL SOLAR RADIATION FOR SEPTEMBER
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT SOLAIRE GLOBAL POUR SEPTEMBRE
(Mégajoule par mètre carré)


CANADA
MEAN DAILY GLOBAL SOLAR RADIATION FOR OCTOBER
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT SOLAIRE GLOBAL POUR OCTOBRE
(Mégajoule par mètre carré)


CANADA
MEAN DAILY GLOBAL SOLAR RADIATION FOR NOVEMBER
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT SOLAIRE GLOBAL POUR NOVEMBRE
(Mégajoule par mètre carré)


CANADA
MEAN DAILY GLOBAL SOLAR RADIATION
FOR DECEMBER
(Megajoule per square metre)
MOYENNE JOURNALIÈRE DU RAYONNEMENT
SOLAIRE GLOBAL POUR DÉCEMBRE
(Mégajoule par mètre carré)


CANADA
ANNUAL MEAN DAILY GLOBAL SOLAR RADIATION
(Megajoule per square metre)
MOYENNE ANNUELLE JOURNALIÈRE DU RAYONNEMENT SOLAIRE GLOBAL
(Mégajoule par mètre carré)

MEAN HOURLY GLOBAL SOLAR RADIATION ON A HORIZONTAL SURFACE
MOYENNE HORAIRE DU RAYONNEMENT SOLAIRE GLOBAL SUR UNE SURFACE HORIZONTALE (MJ/m²)

KUUJJUAQ

	Hour/Heure																							
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	mean daily
JAN JAN								*	0.04	0.21	0.40	0.50	0.50	0.40	0.21	0.04	*								2.30
FEB FÉV							*	0.07	0.30	0.59	0.84	0.98	0.98	0.84	0.61	0.32	0.07	*							5.60
MAR MARS						0.01	0.13	0.46	0.88	1.26	1.56	1.70	1.70	1.54	1.26	0.89	0.48	0.13	0.01						12.01
APR AVR					0.02	0.16	0.50	0.96	1.40	1.78	2.07	2.22	2.23	2.10	1.81	1.44	1.01	0.55	0.18	0.02					18.43
MAY MAI				0.01	0.11	0.33	0.63	0.96	1.29	1.62	1.81	1.93	1.97	1.87	1.63	1.37	1.04	0.69	0.36	0.13	0.02				17.77
JUN JUIN			*	0.05	0.22	0.47	0.79	1.09	1.40	1.64	1.80	1.87	1.86	1.74	1.63	1.40	1.11	0.79	0.49	0.23	0.06	*			18.64
JUL JUIL			*	0.03	0.17	0.38	0.68	0.97	1.26	1.48	1.66	1.75	1.78	1.73	1.56	1.32	1.05	0.75	0.45	0.18	0.03	*			17.23
AUG AOÛT				*	0.04	0.19	0.45	0.76	1.08	1.31	1.47	1.57	1.57	1.48	1.30	1.06	0.79	0.49	0.22	0.04	*				13.82
SEP SEPT						0.02	0.16	0.41	0.70	0.95	1.11	1.18	1.19	1.09	0.90	0.66	0.41	0.17	0.03						8.98
OCT OCT							0.01	0.10	0.26	0.43	0.65	0.72	0.73	0.65	0.49	0.29	0.10	0.01							4.52
NOV NOV								0.01	0.07	0.23	0.36	0.47	0.47	0.36	0.22	0.07	0.01								2.31
DEC DÉC									0.01	0.11	0.25	0.34	0.35	0.26	0.11	0.01									1.44

* From Canadian Climate Normals, 1951-1980, Vol. 1, Solar Radiation, p. 32. Atmospheric Environment Service, Environment Canada, 1982.

KUUJJUAQ - WIND DATA

PERIOD 1955-80 PERIODE

Lat. 58°06'N Long. 068°25'W Elevation 37 m Altitude

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
PERCENTAGE FREQUENCY														**FREQUENCE EN %**
N	5.4	6.5	9.1	11.8	10.8	11.2	11.8	9.5	7.1	6.4	4.8	4.4	8.2	N
NNE	3.1	2.7	4.7	7.4	7.4	7.9	7.4	5.6	4.6	3.8	3.3	2.4	5.0	NNE
NE	3.2	3.3	5.2	8.3	7.8	8.9	8.1	7.0	4.7	4.2	4.2	3.4	5.7	NE
ENE	1.9	1.6	1.6	3.4	3.7	3.6	3.8	3.5	3.2	2.5	2.6	1.8	2.8	ENE
E	2.0	2.6	1.8	2.8	5.0	4.4	4.5	5.0	3.9	3.3	3.4	2.1	3.4	E
ESE	1.3	0.9	0.6	1.2	1.9	2.0	2.4	2.7	2.2	1.7	1.8	1.4	1.7	ESE
SE	1.3	1.1	1.1	1.5	2.3	2.4	3.2	3.4	2.4	2.6	2.6	1.4	2.1	SE
SSE	1.0	0.7	0.9	1.1	1.7	1.6	2.2	2.2	1.7	1.9	2.1	0.9	1.5	SSE
S	6.3	5.3	3.4	3.5	5.0	4.9	6.2	5.7	6.4	6.0	6.8	5.8	5.4	S
SSW	9.0	7.0	4.4	3.2	3.0	3.3	3.5	4.7	5.6	7.5	10.7	10.7	6.0	SSW
SW	17.1	14.4	9.1	6.5	5.1	5.1	5.8	8.7	11.4	10.3	13.8	19.0	10.5	SW
WSW	13.2	12.5	9.9	6.6	5.9	6.7	6.8	8.0	9.7	10.2	9.5	12.0	9.3	WSW
W	9.8	12.7	12.9	10.6	11.5	10.9	9.4	10.5	13.7	15.7	11.5	10.9	11.7	W
WNW	3.5	4.1	4.4	4.6	6.5	5.9	4.0	4.7	6.1	7.0	5.7	4.3	5.1	WNW
NW	4.7	6.7	8.9	7.9	7.5	7.2	7.5	5.9	6.7	7.3	6.6	5.9	6.9	NW
NNW	4.7	5.4	8.4	8.1	6.9	6.5	6.3	5.7	4.6	4.1	4.0	3.9	5.7	NNW
Calm	12.5	12.5	13.6	11.5	8.0	7.5	7.1	7.2	6.0	5.5	6.6	9.9	9.0	Calme
MEAN WIND SPEED IN KILOMETRES PER HOUR														
VITESSE MOYENNE DES VENTS EN KILOMETRES PAR HEURE														
N	23.7	23.6	20.0	18.9	16.6	16.1	16.0	16.1	18.7	17.8	21.0	24.5	19.4	N
NNE	27.6	27.5	22.6	20.9	19.3	19.0	18.1	15.0	18.5	20.2	25.6	25.8	21.7	NNE
NE	22.1	19.5	18.4	18.0	17.2	17.1	16.8	15.4	16.3	19.3	23.3	24.9	19.0	NE
ENE	20.8	18.7	15.0	17.9	15.5	16.6	15.4	14.3	15.6	17.1	19.7	21.0	17.3	ENE
E	14.1	17.7	15.7	15.8	15.2	14.4	13.0	13.5	14.7	14.2	15.0	17.5	15.1	E
ESE	16.3	18.8	14.3	18.6	15.3	13.6	13.2	14.6	14.2	14.0	16.1	18.8	15.7	ESE
SE	13.1	15.0	14.9	16.1	14.0	13.3	12.6	14.9	12.7	14.2	15.3	14.3	14.2	SE
SSE	13.1	13.3	12.2	18.9	14.9	15.0	13.5	14.5	14.6	13.8	16.0	14.6	14.5	SSE
S	13.2	13.2	11.8	14.9	14.2	14.8	14.5	15.6	16.5	16.3	16.7	14.5	14.7	S
SSW	15.0	14.7	13.9	16.7	16.7	18.1	15.7	15.5	17.5	17.0	15.7	14.7	15.9	SSW
SW	15.9	16.5	15.0	17.6	17.1	18.3	17.0	17.5	18.2	18.2	15.9	14.4	16.8	SW
WSW	21.6	19.9	20.2	20.5	20.5	19.6	19.0	19.3	19.8	19.5	17.6	17.8	19.6	WSW
W	20.2	19.0	19.5	19.8	19.3	18.5	18.2	18.2	19.8	19.5	18.1	18.3	19.0	W
WNW	21.7	21.3	18.5	18.9	19.7	18.7	17.0	16.6	19.5	22.4	20.4	21.8	19.7	WNW
NW	19.0	20.5	18.2	17.8	17.1	16.4	15.5	15.1	17.5	19.6	20.3	21.6	18.2	NW
NNW	21.0	22.8	20.8	18.7	16.7	17.6	16.0	16.9	17.7	19.5	20.1	22.4	19.2	NNW
All Directions														**Toutes directions**
	18.4	18.6	15.8	16.4	16.0	15.9	15.1	15.1	16.8	17.5	17.0	16.2	16.2	
Maximum Hourly Speed														**Vitesse horaire maximale**
	109 N	89 WNW	97 WNW	71 NE	77 WSW	80 SVL	74 W	84 SSW	85 N	77 NNW	101 NNE	97 SW	109 N	
Maximum Gust Speed														**Vitesse maximale des rafales**
	161 W	124 WNW	137 WNW	103 ESE	80 NNW	84 W	100 WSW	103 W	145 N	119 NNW	127 NNE	129 N	161 W	

Height of anemometer 14.9 m hauteur de l'anémomètre

STATION INFORMATION

Station is located on higher ground on the west side of Fort Chimo settlement, about 1 km north-east of Airport and 1.5 km northwest of Koksoak River. The U2A anemometer is located at the Aerport site approximately 1 km from the station.

DONNÉES RELATIVES A LA STATION

La station se dresse sur une terrain élevé, du côté ouest de l'établissement de Fort Chimo, à environ 1 km au nord-est de l'aéroport et à 1.5 km au nord-ouest de la rivre Koksoak. L'anémomtre se trouve à l'emplacement de l'séroport, à environ 1 km de mile de la station

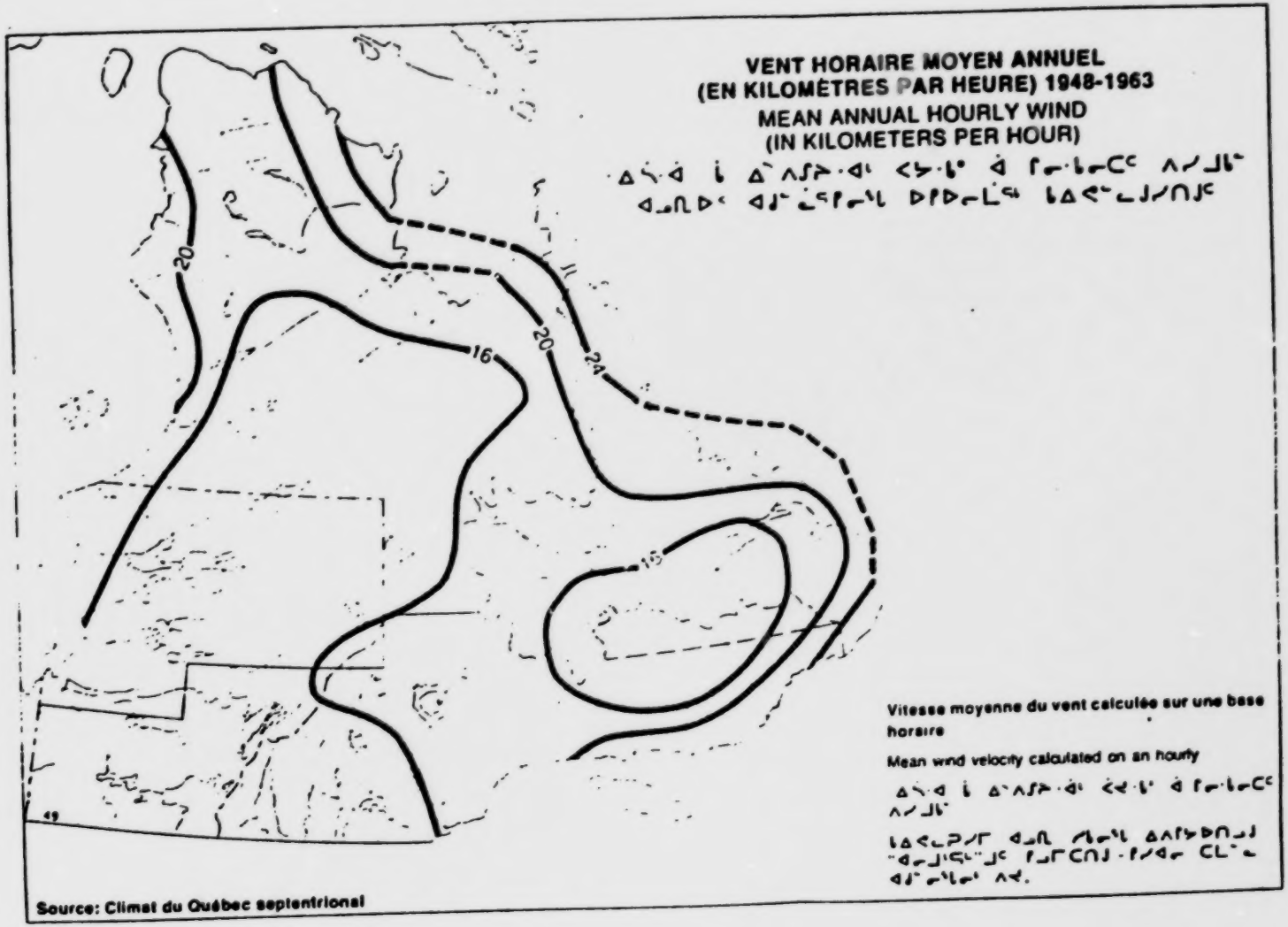
* From Canadian Climate Normals, 1951-1980, Vol. 5, Wind, p. 89. Atmospheric Environment Service, Environment Canada, 1982.

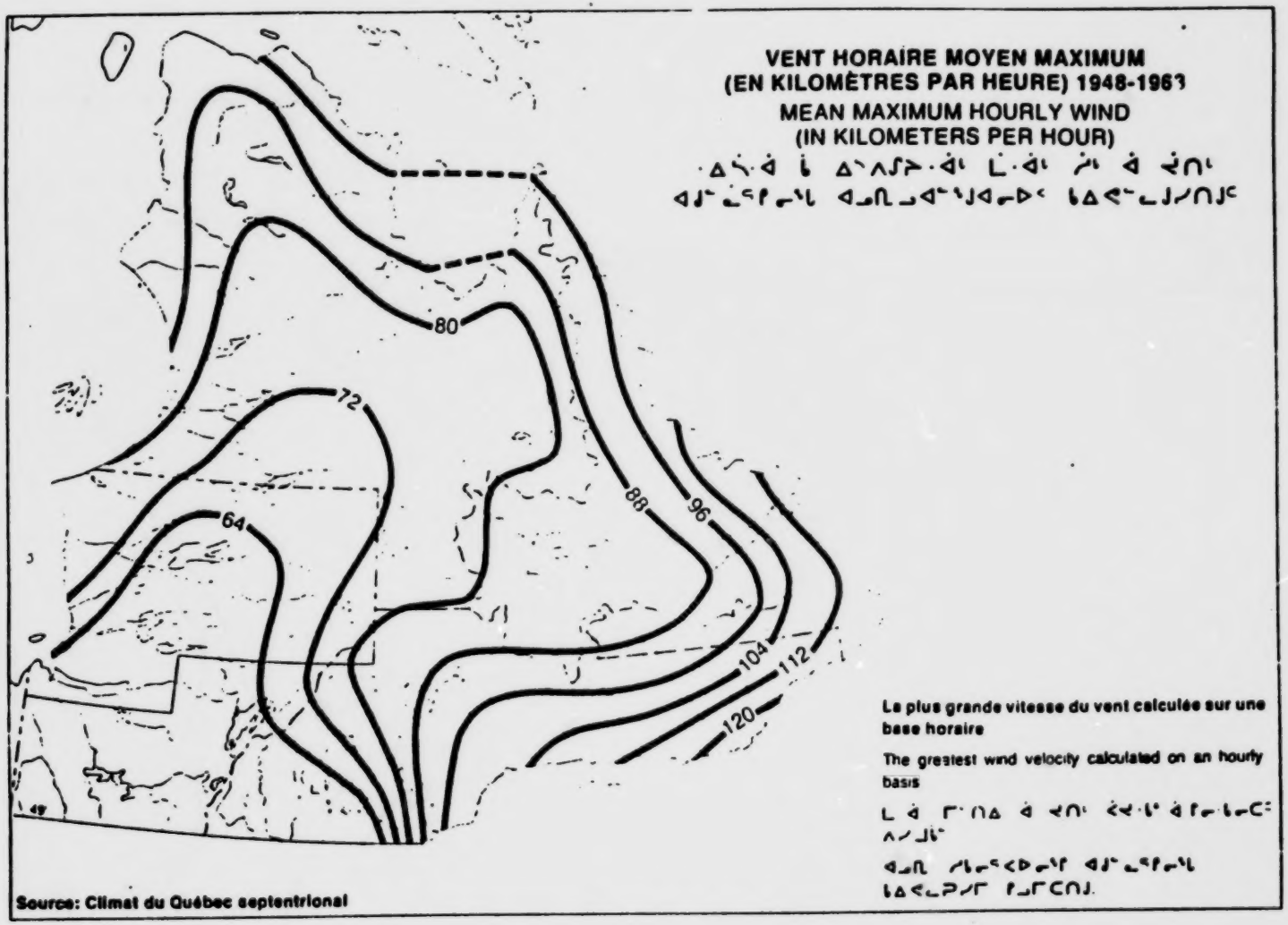
Wind Speed - Kangirsuk **

- Mean wind speed in km per hour, from all directions

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
mean wind speed	19.1	20.5	17.9	19.4	18.9	17.4	17.4	19.2	20.3	24.2	25.1	20.5	20
% of time calm	5.1	5.3	7.8	5.6	3.1	2.8	2.6	2.6	2.3	2.0	2.4	4.2	3.8

** Data obtained by interpolation between Kuujjuaq and Quaqtaq data.


VENT HORAIRE MOYEN ANNUEL
(EN KILOMÈTRES PAR HEURE) 1948-1963
MEAN ANNUAL HOURLY WIND
(IN KILOMETERS PER HOUR)
ᐃᓕᓴ ᐃ ᐃᓐᓇᕐᓂᑦ ᑮᓴᒃᑲ ᐅ ᒥᓯᒃᓯᑦᑕ ᐱᓕᒪᒃ
ᐅᓗᑎᐅᑦ ᐅᓪᓗᓂᑦᓯᓐᓂᒃ ᐅᑭᐅᓕᒪᓐᓇᖅ ᑲᐃᓐᓂᕐᓂᑦᓯᓐᓂᒃ
20
16
20
24
16
49
Vitesse moyenne du vent calculée sur une base horaire
Mean wind velocity calculated on an hourly
ᐃᓕᓴ ᐃ ᐃᓐᓇᕐᓂᑦ ᑮᓴᒃᑲ ᐅ ᒥᓯᒃᓯᑦᑕ ᐱᓕᒪᒃ
ᑲᐃᓐᓂᕐᓂᑦᓯᓐᓂᒃ ᐅᓪᓗᓂᑦᓯᓐᓂᒃ ᐊᒻᒪᓗᒃ ᐃᓕᓴᕐᓂᖅ
"ᐅᓪᓗᑎᒃᑯᑦ ᒥᓯᒃᓯᑦᑕᓂᖅ ᑭᒃᑯᓕᒫᖅ ᑕᒪᒃᑯᐊᒃ
ᐅᓪᓗᓂᑦᓯᓐᓂᒃ ᐱᓕᒪᒃ.
Source: Climat du Québec septentrional



VENT HORAIRE MOYEN MAXIMUM
(EN KILOMÈTRES PAR HEURE) 1948-1963

MEAN MAXIMUM HOURLY WIND
(IN KILOMETERS PER HOUR)

ᐅᕆᐅᑦ ᐃ ᐅᑎᐱᓕᐅᑦ ᒪᐅᑦ ᓂᑎ ᑯ ᕕᑎᑦ
ᐊᒍᑦᓯᖏᓐᓂᑦ ᐊᓗᑎᓗᐊᖅᑐᑦᓴᐊᓕᒃᑐᐅᑦ ᑲᐅᕐᑦᓯᔪᓐᓇᔪᑦ

La plus grande vitesse du vent calculée sur une base horaire

The greatest wind velocity calculated on an hourly basis

ᒪᑯ ᑕᑎᐅᐃ ᑯ ᕕᑎᑦ ᕿᕐᑎᑦ ᑯᒥᖏᓕᒃᓕᑦ ᐱᓯᒪᔪᑦ.

ᐊᓗᑎ ᓂᖏᓐᑦᑐᐅᓂᒃ ᐊᒍᑦᓯᖏᓐᓂᑦ ᑲᐅᕐᑦᓯᔪᓐᓇᔪᑦ.

Source: Climat du Québec septentrional

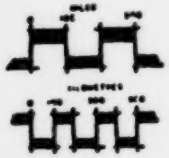
TEMPERATURE DATA (^{o}C) - KANGIRSUK

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
mean daily	-22.6	-22.5	-18.6	-11.1	- 2.2	3.6	7.9	7.7	4.0	-1.4	-7.5	-17.3	- 6.6
mean daily max	-18.4	-18.2	-14.0	- 6.1	1.1	7.1	12.4	11.2	6.8	0.9	-4.6	-12.7	- 2.9
mean daily min	-26.7	-26.8	-23.2	-15.7	-5.5	0.0	3.5	4.0	1.3	-3.6	-10.3	-21.0	-10.3

TEMPERATURE DATA (^{o}C) - KUUJJUAQ

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
mean daily	-23.3	-22.4	-17.7	- 9.2	0.2	6.9	11.4	10.4	5.4	-0.9	- 8.3	-18.4	- 5.5
mean daily max	-18.8	-17.4	-12.5	- 4.3	4.2	12.1	16.9	15.1	9.1	2.0	- 4.7	-14.2	- 1.0
mean daily min	-27.8	-27.4	-22.9	-14.0	-3.7	1.7	5.8	5.7	1.6	-3.7	-11.8	-22.5	- 9.9

* Kuujjuaq data from Canadian Climate Normals, 1951-1980, Vol. 2, Temperature and Precipitation, p. 55. Atmospheric Environment Service, Environment Canada, 1982.



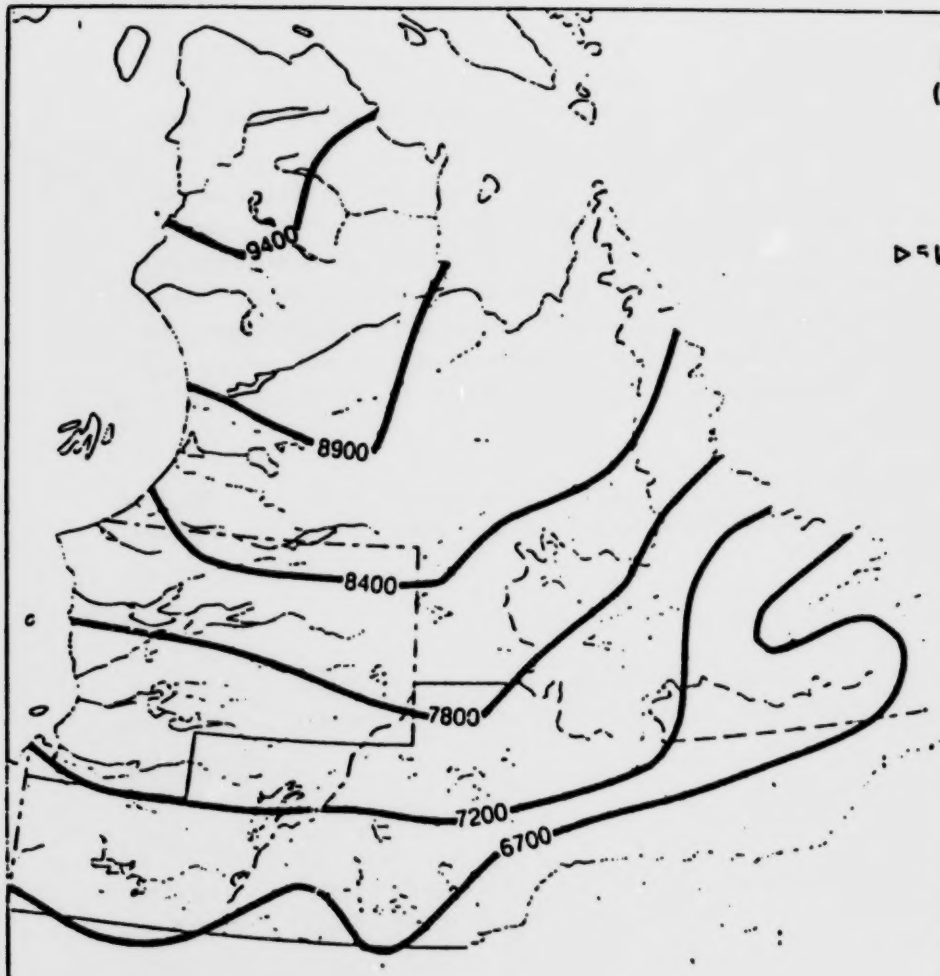
VER REDRAWN FROM SOURCE CROME, A CLIMATIC CLASSIFICATION OF THE NORTHWEST TERRITORIES FOR RECREATION AND TOURISM, Chart 13 (°F converted to °C)

NUMBER OF DEGREE-DAYS** FOR KANGIRSUK and KUUJJUAQ

Below 0.0°C	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
*Kangirsuk	697.0	636.6	574.7	328.8	101.5	5.9	0.0	0.0	1.7	63.8	228.8	538.4	3177.2
Kuujjuaq	726.8	634.1	550.4	281.1	48.8	0.7	0.0	0.0	1.3	62.2	251.5	571.1	3128.0
Below 18.0°C													
*Kangirsuk	1254.8	1145.3	1133.7	866.6	627.3	439.6	312.0	317.6	416.9	598.7	766.7	1095.2	8974.4
Kuujjuaq	1284.8	1142.7	1107.8	815.0	550.5	337.0	208.8	235.4	378.2	584.2	787.6	1128.7	8560.7
Std. Dev. of DD													
Kangirsuk	131.7	106.8	117.3	64.4	56.2	43.8	34.3	44.5	32.6	49.7	101.1	110.8	498.8
Kuujjuaq	131.9	105.4	131.2	106.0	67,3	50.7	31.2	37.2	36.9	57.8	68.4	124.9	421.5

** A degree day is defined as a measure of the departure of the mean temperature for the day from some reference temperature. To calculate the mean temperature for a single day, first add together the minimum and maximum daily temperatures and divide the total by 2. The mean is then subtracted from the selected reference temperature such that each degree Celsius below that reference temperature is counted as 1 degree day. The number of degree days for each month is then computed as the sum of the totalled daily degree days for each day in that month.

* Data obtained by interpolation between data for Kuujjuuaq and Quaqtaq.



FACTEUR CALORIFIQUE ANNUEL
(DEGRÉS-JOURS DE CHAUFFAGE)
1931-1960

ANNUAL HEAT FACTOR
(DEGREE-DAYS OF HEATING)

Nombre annuel moyen de degrés-jours au-dessous de 18.3°C. Le calcul des degrés-jours (n) est basé uniquement sur la valeur de la température moyenne quotidienne (Tm). Si Tm > 18.3 C., n = 0; si Tm < 18.3°C., n = 18.3 - Tm. La somme des valeurs quotidiennes pour une année donne le nombre total annuel de degrés-jours.

The mean annual number of degree-days below 18.3°C. Degree-days (n) are calculated solely on the basis of the mean daily temperature value (Tm). When Tm > 18.3°C., n = 0, when Tm < 18.3°C., n = 18.3°C - Tm. The sum of daily values in one year measures the total annual number of degree-days.

Source: Climat du Québec septentrional

ANNEX E TO APPENDIX B

ANNOTATED BIBLIOGRAPHY

At the beginning of this project a literature search was conducted. The following databases were consulted.

Energyline
NTIS
CISTI Current Catalogue
Engineering Index
COLD

A total of 308 titles were accessed.

BACKGROUND

Audet, Louise and Kativik Regional Government. Corporation of the Northern Village of Kangirsuk/Master Plan. Kativik Regional Government, P.O. Box 9, Kuujjuaq, Quebec. September 1982.

This is an invaluable document, listing physical, social and land use characteristics of the northern village of Kangirsuk. Municipal development problems, potentials and constraints are described in some detail. Appendices include an outline of a zoning plan, data sheet of buildings and numerous maps and tables are scattered throughout.

Audet, Louise and Kativik Regional Government. Corporation of the Northern Village of Kuujjuaq, Quebec. Kativik Regional Government, P.O. Box 9, Kuujjuaq, Quebec. July 1981.

Basically identical in format to the Kangirsuk Master Plan, listing detailed information on the municipality of Kuujjuaq.

Center for Northern Studies. Introduction to Eskimo Culture and Adaptation, Hunting and Gathering Adaptations. Wolcott, VT., USA.

This short paper is an introduction to the geographical characteristics and consequent relationships between environment and plant/animal populations in the far north. It includes a brief discussion about theories of the origin of Inuit culture from a historical and anthropological perspective.

Center for Northern Studies. Evolution of Cultural Groups. Wolcott, VT., USA.

Presents a historical overview of Inuit cultures from the 3000 BC Denbigh groups through the Pre-Dorset, Dorset, Thule and contemporary. Emphasis is placed on the versatility and flexibility of the overall culture as well as on differences between groups. This history forms the basis for the author's thesis that the modern-day Inuit will adapt to and modify current cultural changes.

Director of the Services of Environmental Protection, officials from the Ministry of Municipal Affairs, Ministry of Public Works, and The Environmental Protection Agencies. Municipal Services in Inuit Territory: Part I. Problems in Sanitary Engineering. Prepared for: S.A.G.M.I. at the request of the cabinet.

The first section of this report is a detailed description of current drinking water, grey and black water, and garbage disposal systems in Inuit villages of Nouveau-Quebec. Both Kuujjuaq and Kangirsuk are included in the study. Committee participants recommend changes, few of which have been implemented to date. The 2nd section details existing and recommended municipal infrastructures considered essential to community life.

Gerein, H.J.F. Community Planning and Development in Canada's Northwest Territories. Government of Northwest Territories, Canada Mortgage and Housing Corporation and Department of Indian and Northern Affairs Canada. March 1980.

This report gives background data on Northwest Territory's environment, population, economy etc. and on the government's organization. It also explains the NWT's town planning systems and describes municipal services and building technologies.

Gouvernement du Quebec. Le Nord du Quebec - Profile Regional. Office de Planification et de developpement du Quebec, Quebec. 4e trimestre 1983. Biblioteque nationale du Quebec. ISBN -2-551-05867-8.

This book gives a brief historical, economic and infrastructure profile of each of 21 Cree and Inuit communities in Northern Quebec. In addition, regional, resources, including energy, mines, forest, animals, fish and water are detailed in tables, maps and charts. The land, its evolution, and current topography: the population, its history, traditions, changes and governing structures; and the climate, including wind, precipitation and temperature, are all dealt with in some detail.

McGarry, M.G., T. Jackson, W. Rybszynski, A.V. Whyte, A.P. Zimmerman. Appropriate Technologies for Water Supplies and Sanitation in Northern Communities. Presented At: The Symposium on Utilities Delivery in Northern Regions. March, 1979.

Documents current systems and focuses on the need to develop low-cost appropriate technologies to improve both sanitation and the quality of life. Review of some alternative technologies in place.

ECONOMICS

Kemp, W.B., and G. Wenzel, N. Jensen, and E. Val. The Communities of Resolute and Kuvinaluk: A Social and Economic Baseline Study. McGill University. 1977.

Chapter 7 of this book traces the development of a cash economy in two communities from an earlier trapping-trading phase to the present wage labour dominant period. Household income sources and distribution as well as costs of living and hunting are analysed. The chapter concludes that the economy functions on the demand for services generated locally and is not dependent on projects outside the communities. People are employed close to home and prefer it that way. Work and level of pay are integrated into a productive return on hunting, which in turn reduces the overall costs of living.

Therien, Francois. The Economy North of 55°: some facts and figures. Projet Nord, Departement de Sante Communautaire, Centre Hospitalier de l'Universite Laval, Quebec. 1982.

This report examines the 1980 employment situation in the 13 municipalities north of the 55th latitude. Inuit and non-Inuit shares in the various employment sectors and income are tabulated and analysed.

CLIMATE

Environment Canada. Canadian Climate Normals, 1951-1980: Volume 1. Solar Radiation; Volume 2. Temperature; Volume 3. Precipitation; Volume 4. Degree Days; Volume 5. Wind. Atmospheric Environment Service, Canadian Government Publishing Centre, Supply and Services Canada, Ottawa. 1982.

CONSERVATION TECHNOLOGIES

Brommeland, R.S., P.Eng., Manecon Partnership. Hay River High Pressure Sodium Street Lighting. Report prepared for Energy Conservation Division, Department of Public Works. Government of the N.W.T. and funded by Energy Conservation Division, Department of Public Works, Government of the N.W.T. and Energy, Mines and Resources Canada. Canada/Northwest Territories Conservation and Renewable Energy Demonstration Program. March 1984.

Report on the town project of converting 420 mercury vapour streetlights to use high pressure sodium lamps. Northland Utilities successfully developed two types of mounting plates for the new ballast assemblies. The total investment was $66,017 and savings of the energy bill during the first year are estimated to be 34% ($45,224 from a prior cost of $130,586).

Ferguson, Simek, Clark, Ltd. Arena Ice Plant Waste Heat Recovery. Energy, Mines and Resources Canada. Canada/Northwest Territories Conservation and Renewable Energy Demonstration Program. Heat Recovery Retrofit Project. May, 1982.

Report describing a method of modifying an Ice Areana so that the waste heat produced by the condensers is used for space heating of the arena itself. Good technical details.

Ferguson, Simek, Clark, Ltd. Fort Providence Waste Heat Recovery. Energy, Mines and Resources Canada. Canada/Northwest Territories Conservation and Renewable Energy Demonstration Program.

Report describing an excellent owner-designed and built diesel generator/heat recovery / district heating / radiant floor system. On a capital outlay of $50,000, not including time spent by the owner, monthly savings of $2,500 are being realized. Many design and material innovations described are particularly relevant to conditions in Northern Quebec.

RENEWABLE TECHNOLOGIES

Canadian Energy Development Systems. Small Scale Wood Gasification for Electricity Production in Ontario Remote Communities: Phase I - System Selection & Analysis. Ontario Minsitry of Energy. February, 1983.

Researchers found that National Synfuels Inc. (NSI) gasifier genset system was the most cost-effective system for producing electricity in remote communities provided the average diesel generation cost is in the vicinity of 34¢/kWh. They recommended that the Ministry of Energy subsidize a demonstration project in Ramsey, Ontario to serve as a model.

Levert, France. Petites Centrales de l'Ungava: Evaluation Comparative de Sites. Vice-presidence Environnement, Hydro-Quebec, Montreal. January, 1983.

An earlier version of "Petites Centrales de la Peninsule D'Ungava: Rapport D'Evaluation Sommaire." This earlier report includes a section on the energy potential from tides around Ungava Bay. Nine sites are mentioned, 3 in the Kuujjuaq area and 1 in the Kangirsuk area. Total estimated installed capacity for the nine sites would be 26,416 MW.

Manecon Partnership. Wind Energy for Remote Living. Energy, Mines and Resources Canada. Canada/Northwest Territories Conservation and Renewable Energy Demonstration Program. May 1983.

Report on project conducted by Roland and Anne Brandt to install and operate a small wind power turbine and generator system which they use for domestic lighting and other small appliances. Researchers conclude that the system itself is not cost-effective. It was made so by the ingenuity of the Brandts in assembling used materials and equipment and integrating them into a workable system.

Morton & Partners Ltd. Remote Community Hydro Feasibility Study - Oba. Ontario Ministry of Energy. April 1983.

Report on selection and evaluation of a small hydro-power generating site for a remote community in Northern Ontario. Very detailed budgets could serve as useful models.

Ontario Ministry of Energy. Choosing a Wind Power System - A Handbook for Potential Wind Power Users. Ontario Government Bookstore, 880 Bay Street, Toronto, Ontario.

State-of-the-art overview, equipment assessment and sample calculations to help the user evaluate and choose a windpower system. Listings of Canadian and American manufacturers of wind systems.

Ontario Ministry of Energy. Muskrat Dam Hydro Development. 1983.

Preliminary feasibility study for installing two 100 kW Mini Hydel Stations upstream of Muskrat Dam Lake. Careful consideration of negative environmental, social and cultural impacts are weighed against long-term benefits to the community standard of living and resource base aspirations. Good model for looking at technology impacts.

Robillard, Paul and Edward Gertler. Middleton Associates. Assessment of the Barriers to Alternative Remote Power Systems. Prepared for: The Ontario Ministry of Energy. November, 1982.

This study was commissioned to examine the overall progress of remote community electrification in Ontario and the perceived existence of "barriers" that inhibit the use of alternatives to diesel generation of electricity. The alternative technologies considered are micro-hydro, wood gasification, and wind diesel hybrid systems. Perceived barriers include: institutional inertia, economics, reliability, licenses and approvals and technology fit. The study recommends demonstration projects involving alternative technologies, revised cost-sharing arrangements, and improved coordination between federal and provincial agencies involved in the provision of electrical service. Much of the information contained in the report is relevant to villages in Northern Quebec.

Robillard, Paul et al. Remote Community Energy Assessments, Kayahna Region: Phase I: Final Report. Ontario Ministry of Energy and Energy, Mines and Resources Canada. September, 1982.

Evaluation of 7 communities in the Kayahna Region, identifying potential for renewable energy resources. Conclusions of the study were that renewables can make a very significant contribution to reducing conventional methods of producing electricity and are compatible with the needs of the community.

Robillard, Paul et al. Assessment of Alternative Electricity Generation Technologies: Phase II: Final Report. Prepared for: Kayahna Tribal Area Council, Ontario Ministry of Energy and Energy, Mines and Resources Canada. September 1982.

Of the ten technologies assessed, biomass to electricity conversion, wind and micro-hydro were judged to be most appropriate for communities considered in this study. Recommended conservation approaches were home energy conservation, improved efficiency for existing diesel generators and improved fuel transportation systems.

Rougerie, J.F. Petites Centrales de la Peninsule D'Ungava: Rapport D'Evaluation Sommaire Environment. Vice-Presidence Environnement Hydro-Quebec, Montreal, Quebec. October, 1983.

Forty-four sites were selected as potential locations for small hydro-electric installations around Ungava Bay. Only 13 of these sites were considered suitable for preliminary evaluation. Potential sites around Kuujjuaq and Kangirsuk, among others, are described and evaluated from environmental and other considerations. Three sites, none of them near Kuujjuaq or Kangirsuk, are indicated as deserving attention.

Schienbien, L.A. Design, Development and Testing of a Vertical Axis Wind Turbine Assisted Diesel Generator System. Prepared for: The Ontario Ministry of Energy. March, 1984.

Detailed study to determine the economic and maintenance feasibility of a wind/diesel system for remote communities.

ENERGY - GENERAL

Belanger, Paul. Remote Community Energy Use, Quebec Overview Study. Transtec, Montreal, Quebec. 1982.

Excellent data base on remote communities in Northern Quebec. Data on both Kuujjuaq and Kangirsuk are included.

Kemp, William B. "The Flow of Energy in a Hunting Society". Scientific American. September 1971.

Fascinating analysis of energy flow in two Inuit households. Includes data on energy consumption and comfort levels in traditional and non-traditional shelters.

Ralph Hedlin Associates, Middleton Associates and Van Ginkel Assoc. Remote Community Data Base, Volumes 1 & 2. Prepared for: The Ontario Ministry of Energy. September, 1982.

Data base on 17 remote communities in Ontario. Includes current energy usage and renewable resource base.

HOUSING - GENERAL

Bigue, Lucie and Serge Pageau. Housing in Inuit Nouveau-Quebec. Societe D'Habitation du Quebec, HEMAI. September, 1980.

This 110 page document first reviews all past government housing initiatives in northern Quebec. It indicates the good intentions that were at the root of the early efforts and reveals the dependency that resulted. Existing housing stock and current needs are assessed from perspectives of physical performance and habitability. One chapter inventories advantages and disadvantages of construction methods used in public housing. Ten specific recommendations are given to draw upon adequate housing policy for the North.

Bushey, Richard. Project Coordinator. Northern Residential Standards for Energy Efficient Housing, Draft 4. Energy, Mines and Resources Yellowknife, Northwest Territories., 2NI. February, 1984.

Draft report regarding suggested standards for residential construction in the North. Detailed specifications for each aspect of the building including plumbing, ventilation and site development. Throughout, the committee attempts to tailor design, construction and materials to the particular conditions of the north. Appendix A. Commentary, provides an overview of the rationale behind these specifications.

Chill, R.W.C. Design Guidelines and Technology for Northern Housing Construction. Prepared for: Indian and Northern Affairs Canada. (French & English)

This is an extremely detailed examination of northern housing; problems and potential solutions, ranging from siting to foundations, framing techniques to adequate air changes in new tighter construction. Graphics on construction details are uniformly excellent.

Kativik Regional Government. Working Document in preparation for their meeting with Q.H.C. regarding the housing program for Northern Quebec. January 9, 1979. Kuujjuaq, Quebec.

Essential reading for anyone concerned with housing in the north. Covers preferences regarding new construction, restoration, rental policy and housing maintenance. The KRG conducted a housing questionnaire and study to develop their information base.

Goliger, Gabriella. "Arctic Housing Update". (no publisher information or date).

Short article for the layperson on the history of northern housing with focus on the experimental designs built by the NWTHC in the Keewatin District of the Northwest Territories.

Perreault, Gaby. "L'Habitation Nordique". Nord/North, Dorval,P.Q. Automne, 1982.

Article focusing on the history of housing in the north, problems that have arisen as a result of the wholesale transfer of southern building technologies to the north, and current efforts on the parts of Inuit and government to develop housing appropriate to the climate and needs of the community.

Societe D'Habitation du Quebec. La Maison Jumelee. 1980.

Two page report outlining an economic argument in favour of duplex housing for northern native people. No mention is made of the cultural preference of northern people for single unit housing.

CONSERVATION - BUILDING DESIGN, CONSTRUCTION, AND RETROFIT

Gordon, Isbel. "Arctic Architecture". Construction Canada. pp 18-25. March 1983.

Article for members of the building trades describing the use of reversed cooler/freezer panels as wall, floor and roof units for experimental housing design in the far north. Includes details on foundation schemes for permafrost areas and quotes extensively from G.H. Johnson, ed. Permafrost: Engineering, Design and Construction. Associate Committee of Geotechnical Research. NRC.

Girvin and Associates, Ltd. Arctic Residential Retro-Fit, Frobisher Bay. Energy, Mines and Resources Canada. Canada/Northwest Territories Conservation and Renewable Energy Demonstration Program. 1984.

Report on various retro-fit techniques used in a house in Frobisher Bay where occupants were highly motivated to save energy. Researchers conclude that increasing the building envelope insulation, installing triple-pane glazing and quilted window covers, and reducing infiltration by installing painted permashield siding as well as caulking and covering all building joints with battens is more cost effective than techniques such as computer modeling, wind generation, and associated storage and active solar collection. The quilted window covers were used during the summer to shield summer light.

Girvin and Associates, Ltd. Energy Efficient Row Housing, Yellowknife, NWT. Borealis Housing Cooperative. Energy, Mines and Resources Canada. Canada/Northwest Territories Conservation and Renewable Energy Demonstration Program.

This project consisted of upgrading thermal insulation, installing heat exchangers and introducing other heat loss reduction measures into the Borealis Housing Cooperative, Ltd., a group of 50 new row houses arranged in nine blocks of common crawlspaces. The report documents construction, actual costs and benefits, technical and operational problems and applicability for future projects.

Haigh, Jane Galblum. "The Superinsulated Perspective House". The Northern Engineer, Volume 15, No. 4.

Description of a house designed by Superinsulated Homes, Inc, for submission to the Alaska Energy Center/Division of Energy and Power Development's residential design competition. For the most part, inappropriate and not particularly innovative.

Holland, Jeff. Energy Efficient Housing Training Completion Report, Kispiox and Moricetown.

Final report from project to build two energy efficient homes in remote communities.

Indian Affairs and Northern Development. Completion Report, Energy Efficient Housing Program: Gitanmaax & Sik-E-Dakh. Gitksan-Wetsn Wet'en District. January 28, 1984.

Report on successful completion of demonstration project involving construction of low-energy houses.

Jenkins, Jeremy. Projects 1970-1984. Shelter Construction and Development Ltd., 9 Lakeshore Drive, Toronto M8V 1Y9.

This is a list of Arctic housing projects designed by Shelter Construction company. It includes a brief description of each project, floor plans, elevations and photographs of the buildings. Emphasis is placed on energy-efficient designs and community decision making on design choices.

Jenkins, Jeremy. Design and Construction of the New Town of Kawawachikamach for the Naskapi. Shelter Construction and Development Limited, 9 Lakeshore Drive, Toronto M8V 1Y9.

Brief description of community planning stage, architectural floor plans and photographs describing this project to design a town for the Naskapi. It is interesting that 95% of families surveyed preferred one-floor bungalow style homes with log cabin flavour, and very clear partitions between living, dining rooms and kitchen.

Johnson, Ralph J. Energy Efficient Residence. U.S. Department of Housing and Urban Development, Washington, D.C.

Side-by-side comparison of energy efficient and conventional residences. Examination of cost-effective conservation techniques.

Kigiak Builders Inc. Northern Housing Concept. Makivik Corporation and Kativik Regional Government.

Suggested design and construction details for three models of northern housing showing elevations and detailed floor plans. Emphasis on reflecting the needs of the community, energy conserving features and tailoring to northern conditions.

Luebs, Donald F. Demonstration and Evaluation of Energy-Efficient Systems for Residential Structures: EER-2. Department of Housing and Urban Development, Washington, D.C.

Follow-up project to side-by-side comparison done by Ralph Johnson on EER-1. Incorporates more advanced design and construction techniques to the new house and reports results of close monitoring for one year. Conclude that an earth coupled heat pump and extra insulation package provide greatest savings. Nominally useful.

Planning Collaborative, Inc. Tumbler Ridge Planning Framework for Energy-Conservation Planners. Prepared for: The Technical Research Division, Policy Development and Research Sector of CMHC. August, 1983.

Tumbler Ridge is a new community being built to accomodate this labour force for the North East Coal development in British Columbia. Because energy supply is locally available and abundant, this community is unusual. Researchers studied feasibility of: A District Heating System for the Town: Cost Effective energy-efficient new housing; Energy-efficient subdivisions; and financing alternatives for energy-efficient housing.

Reid, Crowther and Partners, Ltd. Yellowknife: Comparison and Monitoring of Three Mobile Homes. Energy, Mines and Resources Canda. Canada/Northwest Territories Conservation and Renewable Energy Demonstration Program.

Report of monitoring and comparing three trailers of identical age and manufacture. The first was not modified: the second was retrofitted with a higher-value insulated ceiling, vinyl wallpaper and an addition; the third fitted with a vapour barrier, new drywall, and insulation of the skirting. Results are inconclusive because the third trailer isn't level and has high infiltration rates through windows. Report tentatively that payback on 2nd trailers' modifications is 2½ years and 1280 litres of propane will be saved each year.

Ross, John F. "A House for Rural Alaska". The Northern Engineer, Volume 15, #2.

This is an article describing a design for an energy-efficient home suitable for northern regions.

Ryerson Northern Climate Design Work Group. An Inventory of Cold Climate Research and Design. Ontario Government, Ministry of Municipal Affairs and Housing, Housing Renovation and Energy Conservation Unit. April, 1983.

Catalogue of individual and research groups in the area of cold climate energy conservation and building design. This compendium lists over 5,000 names of individuals involved in the field. They are grouped into 31 energy themes, each of them subdivided into 9 activity areas. As a supplement, a bibliographic listing related to energy design and literature is provided.

Shelter Construction and Development, Ltd. and Martin Associates Architects. Remote Low Energy Housing Demonstration Project 399-8520 for Ontario Ministry of Energy, Phase 1, Report. February 23, 1984.

This demonstration project was charged with designing and building one low energy, low-cost house, one major house renovation, and four energy conservation retrofits of varying costs. Shelter, Ltd. was responsible for the new house and the major renovation while Retrospectors took charge of the other four retrofits. Although work was conducted in Armstrong, Ontario, an area without a permafrost layer, this report contains information relevant to needs in Kangirsuk and Kuujjuaq. Participants worked extensively from the IBI Group's Report, Improving Housing Construction in Remote Small Communities and Rural Areas. Prepared for CMHC, March 1980.

Shelter Construction and Development, Ltd., Martin Associates Architects. Energy Conservation Potential - Non-Residential Buildings, Armstrong, Ontario. Report for Armstrong Area Chamber of Commerce under the Remote Community Demonstration Program, Energy Mines and Resources, Canada. RCDP/PDCE 17. April, 1984.

The purpose of this study was to assess the potential of non-residential buildings in the Town of Armstrong to save fuel oil for space heating through energy conservation. Four out of twenty potential buildings were chosen for analysis, the District School Board Office, the Armstrong Public School, The Royal Canadian Legion and the J&J Hardware Store. They used computer modeling techniques to analyse and prioritize conservation measures. In general, they conclude that energy savings of 60% or more can be achieved with measures having payback periods of five years or less. Suggested priorities, based on relative cost-effectiveness, are as follows: Furnace tune-up and improvement; reductions in air infiltration; roof insulation; and wall insulation. Measures not considered to be cost-effective include rigid insulation applied to the roof or walls, insulated window shutters, and basement floor insulation.

CONSERVATION - MONITORING

Dumont, R.S. and H.W. Orr. Cost of Energy Conservation Measures for New Housing. Building Research Note, Division of Building Research, National Research Council, Ottawa. September 1981.

This paper presents costs in 1981 for homes in Saskatoon. Presents examples of the analysis used.

Dumont, R.S., H.W. Orr and M.E. Lux. Low Energy Prairie Housing: A Survey of Essential Features. Division of Building Research, National Research Council, Ottawa. December 1982.

This report concentrates on reducing infiltration with both air and moisture barriers, super insulation, south facing windows, and internal heat gains. Results of performance analysis, costs and recommendations for future developments are included.

Indian and Northern Affairs Canada. Status Report on Research and Development Project: Energy Efficient Northern Housing, Frobisher Bay, N.W.T. September 1983.

Preliminary results of monitoring performed on two energy-efficient houses in the Northwest Territories. Colour photographs of both interior and exterior of each house, showing various floor plans.

Indian and Northern Affairs Canada. Field Performance Evaluation of Departmental Houses 426 and 598, Frobisher Bay, N.W.T. January 1983.

Observations and analysis of field performance evaluations, focused on air-tightness, insulation performance and indoor air quality. Results of thermographic testing show importance of quality control in placement of vapour barrier and insulation. Researchers suggest filling space behind the drywall to reduce thermal bridging patterns and potential areas of air leakage due to an unsupported air/vapour barrier.

Mill, Peter A.D. Thermography - A New Building Science Tool. Prepared for: The Minister of Supply and Services Canada. Report Series #29. 1979.

Bilingual manual describing principles of building performance investigations and techniques employed. Case studies illustrating how thermography can be used as a tool for locating, identifying and assessing deficiencies in building enclosure systems.

Mill, Peter A.D. Thermographic Diagnosis of Building Envelope Deficiencies. Prepared for: The Minister of Supply & Services Canada. Report Series #28. 1979.

Report on 2 thermographic surveys done on the Confederation Center in Charlottetown, P.E.I. Good technical detail and thermographic pictures showing areas of heat loss.

Orr, H.W. and D.A. Figley. An Exhaust Fan Apparatus for Assessing the Air Leakage Characteristics of Houses. Building Research Note, Prairie Regional Station, Division of Building Research, National Research Council, Ottawa. March 1980.

Description of a prototype exhaust fan, test procedure and analysis of results.

CONSERVATION - TRAINING MATERIALS

Alberta Agriculture, Home and Community Design Branch. Low Energy Home Designs - Design Guidelines and Plans for Energy Efficient Housing. Alberta Print Media Branch, 7000-113 Street, Edmonton, Alberta T6H 5T6.

Twenty separate low-energy home designs with floor plans, elevations, style choices and energy use estimate for each. Simple step-by-step construction details with excellent detailed graphics. Good potential for training tool.

Alberta Energy and Natural Resources. Energy Matters; Solar Energy Matters; Selecting A New Furnace; New Home Energy Checklist; How to Insulate Your Basement-Interior and Exterior Methods.

Series of popular, well-illustrated pamphlets for the lay-person on the above topics.

Argue, Robert and Brian Marshall. The Super-Insulated Retrofit Book - A Homeowner's Guide to Energy Efficient Renovation. Renewable Energy in Canada, 107 Amelia Street, Toronto, Canada. 1981.

Detailed step-by-step guide to converting an existing leaky house to super energy-efficient standards. Good treatment of air quality and excellent graphics for training on weather-ization techniques.

Energy Mines and Resources Canada. Keeping the Heat In. April 1983.

Good training material, graphics and text on soup to nuts energy conserving measures.

Energy Mines and Resources Canada. The Billpayer's Guide to Heating Systems. April 1983

Along the same lines as "Keeping the Heat In", good relevant section on furnace cleaning, maintenance and efficiency testing. Useful resource for training phase.

Energy Mines and Resources Canada. Energy Management for the Future, A Sourcebook of Ideas and Activities for Energy Conservation Learning Programs.

List of audio-visuals, films, games and books for grade-school children. Some energy-conserving ideas that have application for northern communities.

Energy Research Development Group. Energy Efficient Housing - A Prairie Approach. Department of Mechanical Engineering, University of Saskatchewan. 1979. Revised 1982.

Excellent construction details; graphics and text for energy conserving practices on both new and refitted houses. Written for the layperson, good training level information.

Government of Saskatchewan. Preventive Home Maintenance - Homeowner Daily Reference Manual. Northern Saskatchewan. 1977.

This home-owner manual was designed to assist in the Saskatchewan Home Maintenance Program introduced in 1977 (but abandoned in the 1980's). It describes the homeowner's responsibilities and supplies step-by-step maintenance instructions for heating and plumbing systems and electrical systems. Also includes basic carpentry techniques and a guide to first aid.

ANNEX F TO APPENDIX B

HOTCAN HEAT LOSS ANALYSIS PROGRAM

This appendix contains the output of six computer runs on two houses in Kangirsuk. The first house, labelled 455-EX is an unrenovated house built in 1971 with a heated floor area of 59 m^2. All building parameters have been taken directly from SHQ house files and from direct measurements in one of the model 455-EX houses on site in Kangirsuk. Four computer analyses were run on 455-EX with all parameters constant except the assumed natural infiltration rate. The variation in this latter was from one to four air changes per hour. Comparison of computer estimated with actual 1983 heating costs for the house measured on site revealed that the house operated thermally as though it had a natural infiltration rate of three air changes per hour.

The second house, labelled 455-EX RENOV is the same house model above with assumed renovations according to SHQ architectural drawings for Habitation Nordique entitled 'Renovation Architecture 455-EX 82'. The renovated house has an assumed heated floor area of 76.50 m^2. All building parameters used in the HOTCAN program were taken directly from the 455-EX 82 drawings cited above. Two computer analyses were run on 455-EX RENOV with all parameters constant except that the assumed natural infiltration rate was varied from one to two air changes per hour. The renovated house was assumed to be significantly tighter than the unrenovated house.

For both houses, the allowable daily indoor temperature swing was assumed to be 3 ^{o}C on either side of 20 ^{o}C. The weather data used in the HOTCAN program was a modification to the HOTCAN weather file for Fort Chimo. An additional 402 heating degree days per year were added to the Fort Chimo weather data to reflect the cooler overall conditions in Kangirsuk. The daily base electric consumption and the daily hot water energy consumption are different in both houses to correspond to available data from old and renovated houses in the former case, and to correspond to equipment availability in the case of the water heaters.

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*****************************************
*                HOTCAN!                *
*       HEAT LOSS ANALYSIS PROGRAM      *
*          OTTAWA, CANADA - 1984        *
*          (HOTCAN RELEASE 4.02.2)      *
*****************************************
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CLIENT NAME: 455-EX
ADDRESS :

HOUSE DATA FILE NAME: B:KANG1

WEATHER DATA IS FOR FORT CHIMO

*** BUILDING PARAMETERS ***

ELEMENTS	HOUSE VOLUME	AIR CHANGE	HT LOSS W/DEGC	% SEASONAL HT LOSS
VENTILATION	141.6 M3	1/HR	43.68	29.42
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	59.00	2.30		
TOTAL	59.00	2.30	25.65	17.28
MAIN WALLS	93.45	1.84		
TOTAL	93.45	1.84	50.79	34.21
DOORS	6.00	.35		
TOTAL	6.00	.35	17.14	11.55
BASEMENT AB.GD	.00	.00		
TOTAL	.00	.00	.00	.00
BASEMENT 600MM	.00	.00		
TOTAL	.00	.00	.00	.00
BASE. TO FLOOR	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR PERIMETER	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR CENTRE	.00	.00		
TOTAL	.00	.00	.00	.00
SOUTH WINDOWS	2.04	.44		
TOTAL	2.04	.44	4.62	3.11
NORTH WINDOWS	.70	.44		
TOTAL	.70	.44	1.59	1.07
EAST WINDOWS	.70	.44		
TOTAL	.70	.44	1.59	1.07
WEST WINDOWS	1.50	.44		
TOTAL	1.50	.44	3.40	2.29

HOTCAN

S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS :

DESIGN HEAT LOSS AT -39C = 8.91 KW
DEGREE DAYS FOR FORT CHIMO IS 8862
TEMPERATURES (DEG C) MAIN FLOOR = 20 BASEMENT = 20
ALLOWABLE DAILY TEMPERATURE SWING = 6
SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 6.4
DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 14
DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 4
MASS LEVEL CHOSEN IS <A>
BASEMENT INSULATED PRIMARILY FROM THE INSIDE
WINDOW SHADING COEFFICIENTS: SOUTH = .83 NORTH = .83
EAST = .83 WEST = .83
S-EAST = 0 S-WEST = 0
SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1.52 M
AVERAGE OVERHANG WIDTH = .61 M
AVERAGE HEIGHT ABOVE WINDOW = .2 M
NATURAL INFILTRATION RATE (AC/HR) = 1
FORCED VENTILATION RATE (AC/HR) = 0

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	130.80	.04	125.90	143.90
FEB	127.95	.06	119.93	137.93
MAR	111.20	.11	98.66	116.66
APR	80.92	.17	66.96	84.96
MAY	47.42	.21	37.47	55.47
JUN	23.55	.36	15.16	33.16
JUL	7.52	.77	1.74	19.74
AUG	11.08	.55	4.99	22.99
SEP	28.90	.20	23.26	41.26
OCT	51.34	.08	47.08	65.08
NOV	77.71	.05	74.11	92.11
DEC	113.69	.03	110.43	128.43

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
ANNUAL SOLAR HEATING CONTRIBUTION = 11 %

ESTIMATED ANNUAL SPACE HEATING 79 GJ, OR	21,957 KWHRS
SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING =	4,047 KWHRS
PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION =	6,570 KWHRS
SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION =	10,600 KWHRS
TOTAL ANNUAL ENERGY CONSUMPTION =	28,527 KWHRS
TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET =	14,647 KWHRS

*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR KANGIRSUK AS OF 85/02/05

ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
OIL	49.6C/LITRE	$ 1675.55/YR EFF.= 59%	$ 121.54/YR EFF.= 55%	--

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This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.

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*****************************************
*                HOTCAN!                *
*      HEAT LOSS ANALYSIS PROGRAM       *
*        OTTAWA, CANADA - 1984          *
*         (HOTCAN RELEASE 4.02.2)       *
*****************************************
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CLIENT NAME: 455-EX
ADDRESS :

HOUSE DATA FILE NAME: B:KANG1

WEATHER DATA IS FOR FORT CHIMO

*** BUILDING PARAMETERS ***

ELEMENTS	HOUSE VOLUME	AIR CHANGE	HT LOSS W/DEGC	% SEASONAL HT LOSS
VENTILATION	141.6 M3	2/HR	87.36	45.47
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	59.00	2.30		
TOTAL	59.00	2.30	25.65	13.35
MAIN WALLS	93.45	1.84		
TOTAL	93.45	1.84	50.79	26.43
DOORS	6.00	.35		
TOTAL	6.00	.35	17.14	8.92
BASEMENT AB.GD	.00	.00		
TOTAL	.00	.00	.00	.00
BASEMENT 600MM	.00	.00		
TOTAL	.00	.00	.00	.00
BASE. TO FLOOR	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR PERIMETER	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR CENTRE	.00	.00		
TOTAL	.00	.00	.00	.00
SOUTH WINDOWS	2.04	.44		
TOTAL	2.04	.44	4.62	2.41
NORTH WINDOWS	.70	.44		
TOTAL	.70	.44	1.59	.83
EAST WINDOWS	.70	.44		
TOTAL	.70	.44	1.59	.83
WEST WINDOWS	1.50	.44		
TOTAL	1.50	.44	3.40	1.77

HOTCAN

S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS :

DESIGN HEAT LOSS AT -39C = 11.53 KW
DEGREE DAYS FOR FORT CHIMO IS 8862
TEMPERATURES (DEG C) MAIN FLOOR = 20 BASEMENT = 20
ALLOWABLE DAILY TEMPERATURE SWING = 6
SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 6.4
DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 14
DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 4
MASS LEVEL CHOSEN IS <A>
BASEMENT INSULATED PRIMARILY FROM THE INSIDE
WINDOW SHADING COEFFICIENTS: SOUTH = .83 NORTH = .83
EAST = .83 WEST = .83
S-EAST = 0 S-WEST = 0
SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1.52 M
AVERAGE OVERHANG WIDTH = .61 M
AVERAGE HEIGHT ABOVE WINDOW = .2 M
NATURAL INFILTRATION RATE (AC/HR) = 2
FORCED VENTILATION RATE (AC/HR) = 0

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	176.08	.03	171.18	189.18
FEB	172.39	.05	164.38	182.38
MAR	150.72	.08	138.18	156.18
APR	111.53	.13	97.57	115.57
MAY	68.18	.15	57.82	75.82
JUN	37.29	.24	28.48	46.48
JUL	16.54	.46	8.97	26.97
AUG	21.15	.33	14.24	32.24
SEP	44.20	.13	38.36	56.36
OCT	73.25	.06	68.99	86.99
NOV	107.38	.03	103.77	121.77
DEC	153.95	.02	150.69	168.69

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
ANNUAL SOLAR HEATING CONTRIBUTION = 8 %

ESTIMATED ANNUAL SPACE HEATING 113 GJ, OR	31,560 KWHRS
SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING =	4,047 KWHRS
PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION =	6,570 KWHRS
SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION =	10,600 KWHRS
TOTAL ANNUAL ENERGY CONSUMPTION =	38,130 KWHRS
TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET =	14,647 KWHRS

*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR KANGIRSUK AS OF 85/02/05

ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
OIL	49.6C/LITRE	$ 2408.4/YR EFF.= 59%	$ 121.54/YR EFF.= 55%	--

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This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.

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*          (HOTCAN RELEASE 4.02.2)      *
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CLIENT NAME: 455-EX
ADDRESS :

HOUSE DATA FILE NAME: B:KANG1

WEATHER DATA IS FOR FORT CHIMO

*** BUILDING PARAMETERS ***

ELEMENTS	HOUSE VOLUME	AIR CHANGE	HT LOSS W/DEGC	% SEASONAL HT LOSS
VENTILATION	141.6 M3	3/HR	131.03	55.57
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	59.00	2.30		
TOTAL	59.00	2.30	25.65	10.88
MAIN WALLS	93.45	1.84		
TOTAL	93.45	1.84	50.79	21.54
DOORS	6.00	.35		
TOTAL	6.00	.35	17.14	7.27
BASEMENT AB.GD	.00	.00		
TOTAL	.00	.00	.00	.00
BASEMENT 600MM	.00	.00		
TOTAL	.00	.00	.00	.00
BASE. TO FLOOR	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR PERIMETER	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR CENTRE	.00	.00		
TOTAL	.00	.00	.00	.00
SOUTH WINDOWS	2.04	.44		
TOTAL	2.04	.44	4.62	1.96
NORTH WINDOWS	.70	.44		
TOTAL	.70	.44	1.59	.67
EAST WINDOWS	.70	.44		
TOTAL	.70	.44	1.59	.67
WEST WINDOWS	1.50	.44		
TOTAL	1.50	.44	3.40	1.44

HOTCAN

S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS :

DESIGN HEAT LOSS AT -39C = 14.15 KW
DEGREE DAYS FOR FORT CHIMO IS 8862
TEMPERATURES (DEG C) MAIN FLOOR = 20 BASEMENT = 20
ALLOWABLE DAILY TEMPERATURE SWING = 6
SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 6.4
DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 14
DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 4
MASS LEVEL CHOSEN IS <A>
BASEMENT INSULATED PRIMARILY FROM THE INSIDE
WINDOW SHADING COEFFICIENTS: SOUTH = .83 NORTH = .83
EAST = .83 WEST = .83
S-EAST = 0 S-WEST = 0
SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1.52 M
AVERAGE OVERHANG WIDTH = .61 M
AVERAGE HEIGHT ABOVE WINDOW = .2 M
NATURAL INFILTRATION RATE (AC/HR) = 3
FORCED VENTILATION RATE (AC/HR) = 0

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	221.37	.02	216.47	234.47
FEB	216.84	.04	208.83	226.83
MAR	190.24	.07	177.70	195.70
APR	142.14	.10	128.18	146.18
MAY	88.94	.12	78.58	96.58
JUN	51.02	.18	41.78	59.78
JUL	25.55	.32	17.45	35.45
AUG	31.21	.23	24.05	42.05
SEP	59.51	.10	53.66	71.66
OCT	95.16	.04	90.90	108.90
NOV	137.04	.03	133.44	151.44
DEC	194.20	.02	190.94	208.94

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
ANNUAL SOLAR HEATING CONTRIBUTION = 6 %

ESTIMATED ANNUAL SPACE HEATING 148 GJ, OR	41,237 KWHRS
SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING =	4,047 KWHRS
PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION =	6,570 KWHRS
SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION =	10,600 KWHRS
TOTAL ANNUAL ENERGY CONSUMPTION =	47,807 KWHRS
TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET =	14,647 KWHRS

*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR KANGIRSUK AS OF 85/02/05

ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
OIL	49.6C/LITRE	$ 3146.85/YR EFF.= 59%	$ 121.54/YR EFF.= 55%	--

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This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.

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*       HEAT LOSS ANALYSIS PROGRAM      *
*          OTTAWA, CANADA - 1984        *
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CLIENT NAME: 455-EX
ADDRESS :

HOUSE DATA FILE NAME: B:KAN61

WEATHER DATA IS FOR FORT CHIMO

*** BUILDING PARAMETERS ***

ELEMENTS	HOUSE VOLUME	AIR CHANGE	HT LOSS W/DEGC	% SEASONAL HT LOSS
VENTILATION	141.6 M3	4/HR	174.71	62.51
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	59.00	2.30		
TOTAL	59.00	2.30	25.65	9.18
MAIN WALLS	93.45	1.84		
TOTAL	93.45	1.84	50.79	18.17
DOORS	6.00	.35		
TOTAL	6.00	.35	17.14	6.13
BASEMENT AB.GD	.00	.00		
TOTAL	.00	.00	.00	.00
BASEMENT 600MM	.00	.00		
TOTAL	.00	.00	.00	.00
BASE. TO FLOOR	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR PERIMETER	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR CENTRE	.00	.00		
TOTAL	.00	.00	.00	.00
SOUTH WINDOWS	2.04	.44		
TOTAL	2.04	.44	4.62	1.65
NORTH WINDOWS	.70	.44		
TOTAL	.70	.44	1.59	.57
EAST WINDOWS	.70	.44		
TOTAL	.70	.44	1.59	.57
WEST WINDOWS	1.50	.44		
TOTAL	1.50	.44	3.40	1.22

HOTCAN

S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS :

DESIGN HEAT LOSS AT -39C = 16.77 KW
DEGREE DAYS FOR FORT CHIMO IS 8862
TEMPERATURES (DEG C) MAIN FLOOR = 20 BASEMENT = 20
ALLOWABLE DAILY TEMPERATURE SWING = 6
SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 6.4
DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 14
DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 4
MASS LEVEL CHOSEN IS <A>
BASEMENT INSULATED PRIMARILY FROM THE INSIDE
WINDOW SHADING COEFFICIENTS: SOUTH = .83 NORTH = .83
EAST = .83 WEST = .83
S-EAST = 0 S-WEST = 0
SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1.52 M
AVERAGE OVERHANG WIDTH = .61 M
AVERAGE HEIGHT ABOVE WINDOW = .2 M
NATURAL INFILTRATION RATE (AC/HR) = 4
FORCED VENTILATION RATE (AC/HR) = 0

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	266.65	.02	261.76	279.76
FEB	261.29	.03	253.27	271.27
MAR	229.76	.05	217.22	235.22
APR	172.74	.08	158.79	176.79
MAY	109.69	.09	99.33	117.33
JUN	64.75	.14	55.51	73.51
JUL	34.57	.24	26.22	44.22
AUG	41.27	.18	33.77	51.77
SEP	74.81	.08	68.97	86.97
OCT	117.07	.04	112.81	130.81
NOV	166.71	.02	163.11	181.11
DEC	234.46	.01	231.19	249.19

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
ANNUAL SOLAR HEATING CONTRIBUTION = 5 %

ESTIMATED ANNUAL SPACE HEATING 183 GJ, OR	50,934 KWHRS
SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING =	4,047 KWHRS
PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION =	6,570 KWHRS
SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION =	10,600 KWHRS
TOTAL ANNUAL ENERGY CONSUMPTION =	57,504 KWHRS
TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET =	14,647 KWHRS

*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR KANGIRSUK AS OF 85/02/05

ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
OIL	49.6C/LITRE	$ 3886.82/YR EFF.= 59%	$ 121.54/YR EFF.= 55%	--

****

This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.

****

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*****************************************
*                HOTCAN!                *
*       HEAT LOSS ANALYSIS PROGRAM      *
*          OTTAWA, CANADA - 1984        *
*          (HOTCAN RELEASE 4.02.2)      *
*****************************************
```

CLIENT NAME: 455-EX RENOV
ADDRESS :

HOUSE DATA FILE NAME: B:KANG2

WEATHER DATA IS FOR FORT CHIMO

*** BUILDING PARAMETERS ***

ELEMENTS	HOUSE VOLUME	AIR CHANGE	HT LOSS W/DEGC	% SEASONAL HT LOSS
VENTILATION	175 M3	1/HR	53.98	52.22
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	76.50	10.20		
TOTAL	76.50	10.20	7.50	7.26
MAIN WALLS	170.40	5.21		
TOTAL	170.40	5.21	32.73	31.66
DOORS	3.40	1.34		
TOTAL	3.40	1.34	2.54	2.45
BASEMENT AB.GD	.00	.00		
TOTAL	.00	.00	.00	.00
BASEMENT 600MM	.00	.00		
TOTAL	.00	.00	.00	.00
BASE. TO FLOOR	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR PERIMETER	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR CENTRE	.00	.00		
TOTAL	.00	.00	.00	.00
SOUTH WINDOWS	2.40	.68		
TOTAL	2.40	.68	3.53	3.41
NORTH WINDOWS	.70	.68		
TOTAL	.70	.68	1.03	1.00
EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
WEST WINDOWS	1.40	.68		
TOTAL	1.40	.68	2.06	1.99

HOTCAN

S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS :

DESIGN HEAT LOSS AT -39C = 6.2 KW
DEGREE DAYS FOR FORT CHIMO IS 8862
TEMPERATURES (DEG C) MAIN FLOOR = 20 BASEMENT = 20
ALLOWABLE DAILY TEMPERATURE SWING = 6
SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 6.4
DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 15.5
DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 7
MASS LEVEL CHOSEN IS §A¶
BASEMENT INSULATED PRIMARILY FROM THE INSIDE
WINDOW SHADING COEFFICIENTS: SOUTH = .8 NORTH = .8
EAST = 0 WEST = .8
S-EAST = 0 S-WEST = 0
SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1 M
AVERAGE OVERHANG WIDTH = .15 M
AVERAGE HEIGHT ABOVE WINDOW = 0 M
NATURAL INFILTRATION RATE (AC/HR) = 1
FORCED VENTILATION RATE (AC/HR) = 0

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	82.31	.06	77.24	99.74
FEB	80.32	.10	72.43	94.93
MAR	68.66	.17	56.90	79.40
APR	47.58	.25	35.85	58.35
MAY	24.26	.33	16.14	38.64
JUN	7.64	.71	2.19	24.69
JUL	.00	1.00	.00	22.50
AUG	.00	1.00	.00	22.50
SEP	11.36	.44	6.31	28.81
OCT	26.99	.15	22.90	45.40
NOV	45.35	.08	41.72	64.22
DEC	70.40	.05	66.96	89.46

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
ANNUAL SOLAR HEATING CONTRIBUTION = 14 %

ESTIMATED ANNUAL SPACE HEATING 43 GJ, OR	12,054 KWHRS
SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING =	5,002 KWHRS
PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION =	8,213 KWHRS
SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION =	10,600 KWHRS
TOTAL ANNUAL ENERGY CONSUMPTION =	20,267 KWHRS
TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET =	15,602 KWHRS

*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR KANGIRSUK AS OF 85/02/05

ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
OIL	49.6C/LITRE	$ 788.45/YR EFF.= 70%	$ 212.69/YR EFF.= 55%	--

****

This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.

****

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*****************************************
*                HOTCAN!                *
*      HEAT LOSS ANALYSIS PROGRAM       *
*         OTTAWA, CANADA - 1984         *
*         (HOTCAN RELEASE 4.02.2)       *
*****************************************
```

CLIENT NAME: 455-EX RENOV
ADDRESS :

HOUSE DATA FILE NAME: B:KANG2

WEATHER DATA IS FOR FORT CHIMO

*** BUILDING PARAMETERS ***

ELEMENTS	HOUSE VOLUME	AIR CHANGE	HT LOSS W/DEGC	% SEASONAL HT LOSS
VENTILATION	175 M3	2/HR	107.96	68.61
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	76.50	10.20		
TOTAL	76.50	10.20	7.50	4.77
MAIN WALLS	93.90	4.70		
	76.50	6.00		
TOTAL	170.40	5.21	32.73	20.80
DOORS	3.40	1.34		
TOTAL	3.40	1.34	2.54	1.61
BASEMENT AB.GD	.00	.00		
TOTAL	.00	.00	.00	.00
BASEMENT 600MM	.00	.00		
TOTAL	.00	.00	.00	.00
BASE. TO FLOOR	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR PERIMETER	.00	.00		
TOTAL	.00	.00	.00	.00
FLOOR CENTRE	.00	.00		
TOTAL	.00	.00	.00	.00
SOUTH WINDOWS	2.40	.68		
TOTAL	2.40	.68	3.53	2.24
NORTH WINDOWS	.70	.68		
TOTAL	.70	.68	1.03	.65
EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
WEST WINDOWS	1.40	.68		
TOTAL	1.40	.68	2.06	1.31

HOTCAN

S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS :

DESIGN HEAT LOSS AT -39C = 9.44 KW
DEGREE DAYS FOR FORT CHIMO IS 8862
TEMPERATURES (DEG C) MAIN FLOOR = 20 BASEMENT = 20
ALLOWABLE DAILY TEMPERATURE SWING = 6
SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 6.4
DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 15.5
DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 7
MASS LEVEL CHOSEN IS §A¶
BASEMENT INSULATED PRIMARILY FROM THE INSIDE
WINDOW SHADING COEFFICIENTS: SOUTH = .8 NORTH = .8
EAST = 0 WEST = .8
S-EAST = 0 S-WEST = 0
SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1 M
AVERAGE OVERHANG WIDTH = .15 M
AVERAGE HEIGHT ABOVE WINDOW = 0 M
NATURAL INFILTRATION RATE (AC/HR) = 2
FORCED VENTILATION RATE (AC/HR) = 0

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	138.28	.04	133.20	155.70
FEB	135.25	.06	127.36	149.86
MAR	117.51	.10	105.75	128.25
APR	85.41	.14	73.05	95.55
MAY	49.91	.18	41.06	63.56
JUN	24.61	.29	17.38	39.88
JUL	7.62	.69	2.33	24.83
AUG	11.39	.49	5.86	28.36
SEP	30.27	.18	24.97	47.47
OCT	54.06	.08	49.98	72.48
NOV	82.01	.04	78.38	100.88
DEC	120.15	.03	116.71	139.21

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
ANNUAL SOLAR HEATING CONTRIBUTION = 9 %

ESTIMATED ANNUAL SPACE HEATING 84 GJ, OR	23,481 KWHRS
SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING =	5,002 KWHRS
PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION =	8,213 KWHRS
SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION =	10,600 KWHRS
TOTAL ANNUAL ENERGY CONSUMPTION =	31,693 KWHRS
TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET =	15,602 KWHRS

*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR KANGIRSUK AS OF 85/02/05

ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
OIL	49.6C/LITRE	$ 1535.81/YR EFF.= 70%	$ 212.69/YR EFF.= 55%	--

****

This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.

****

APPENDIX C

HOUSE REPORTS DATA

SAMPLE OF HOUSE REPORT

HOUSE NUMBER 109

COMMUNITY Kangirsuk

OCCUPANT NAME Willie Tomassie

Before repairs

1. WINDOWS:	- How many windows in the house?	8
	- How many have broken panes?	6 (+ 1 missing)
	- How many windows open?	all
	- How many do they open in the summer?	all
	- How many windows have single glazing?	3
	- How many with well fitting storm windows or factory sealed double glazing?	none
	- How many have triple glazing?	none
	- How many have poorly fitting storm windows?	-
	- How many opening windows have good weather stripping?	none
	- How many windows have evidence of condensation between glazings?	5
	- How many windows have window frames that need caulking?	8
	- How many windows are drafty in the winter (ask occupants)?	8

2. DOORS:

- How many doors to the outside?	2
- How many doors have holes or not or are otherwise in bad condition?	1
- How many doors do not fit well?	2
- How many doors have storms doors?	0
- How many doors lead off a porch or entryway for which there is another door?	2
- How many of the doors are insulated?	0
- How many doors have poor weather strip?	2
- How many doors with door frames that need caulking?	2
- How many doors are drafty in the winter (ask occupant)?	2

3. OTHERS:

- How many unplugged, straight through, holes in the walls, ceiling, floor?	1
Describe hole above stove= "nose-of the-house"	
- Are there any signs of moisture having came through the ceiling? (yes/no)	no
- Are there any especially drafty parts of the base (ask occupants)	
- wall/floor joints	yes
- ceiling/wall joints	-
- wall/wall joints	-
- Are there any other obvious air leaks, for example	
- holes in the wall	dryer

- around electrical/light	no
- around drain pipes	yes
- around chimneys	no
- around attic hatches	no

After repairs

1. WINDOWS	- How many window panes were repaired?	3
	- How many windows that open were weather stripped?	8
	- How many opening windows were caulked shut?	none
	- How many other windows were caulked?	8
	- How many other windows required extra caulk on the frames or stops?	8
	- How many windows did you double glaze?	none
	- How many windows did you triple glaze?	six out of eight
	- Estimate the total metres of caulk used on all windows and frames.	75 m
	- Estimate the total metres of V-Strip used on all window frames.	25 m
2. DOORS:	-Did you repair holes or other bad conditions in the door? (yes/no)	no
	- Did you take door(s) off hinges to make any necessary repair? (yes/no)	no
	- Did you have to lengthen or shorten any of the door? (yes/no)	yes

- On how many doors did you simply adjust the existing weather strip? 2

- On how many doors did you have to replace the weather strip? -

- How many doors frames did you caulk? 2

- How many storm doors or second doors on an entryway did you repair (weather strip, fix, etc.)? -

- Did you have to add caulking to the porch on entryway to plug holes? (yes/no) -

- Estimate total lineal metres of caulk used on all door/door frames 9.5 m

- Estimate total lineal metres of V-Strip used on all doors. 4 m

- Estimate total lineal metres of weather strip used on all doors. 7.4 m

3. OTHER:

- Did you use foam insulation to plug any holes? (yes/no). If yes, please explain. Yes, nose of house
around drain pipes
around window frames
around dryer pipe

- Did you caulk any ceiling, wall or floor joints?(yes/no). If yes, estimate the total number of lineal metres of caulk used. Yes
25.8m

- How many electricity or light seals did you used? none

- Did you plug any other holes or cracks from the inside - for example around pipes, electrical wires, etc.? (yes/no) Yes
If yes, briefly describe. Around pipes, nose of house etc.

TABLE C-1 SUMMARY OF HOUSE REPORTS-KUUJJUAQ

House #	76	90	106	110	123	124	125	133	184	191	199	J.J.
#Windows	7	5	7	8	7	7	8	6	4	8	6	6
#Broken panes	0	1	0	2	2	0	0	0	1	1	0	0
#with condensation	3	5	7	8	7	7	7	6	4	0	6	3
#Outside doors	2	1	2	2	2	2	2	1	2	3	2	2
#with holes	0	1	1	0	2	2	1	0	2	0	0	2
#not fitting	0	1	0	2	0	0	0	0	1	0	0	0
#with storm door	1	0	1	0	0	2	1	0	1	1	1	1
#to porch	1	1	2	1	2	1	2	1	1	1	1	1
#holes in walls	0	1	1	5	2	2	1	0	6	3	1	0
Moisture on ceiling	yes	yes	yes	yes	yes	no	no	no	yes	no	no	no
#Windows fixed	7	5	3	5	7	3	-	6	2	6	6	6
#Weather-stripped	4	1	3	0	0	0	-	6	0	3	6	6
#caulked shut	4	0	0	0	0	3	-	3	1	3	5	2
#caulked	7	5	5	4	3	0	-	6	0	4	1	4
#frames caulked	7	4	5	4	3	0	-	6	2	3	6	6
#storm windows	7	3	5	5	7	3	-	6	0	6	6	6
#Doors fixed	2	1	2	2	3	-	-	1	0	4	2	2
#holes plugged	1	0	0	0	0	-	-	0	0	1	0	0
#off hinges	0	0	0	0	0	-	-	0	0	0	0	0
#frames caulked	0	0	1	0	1	-	-	0	0	2	0	1
Caulking in porch?	no	no	yes	no	no	-	-	no	no	no	no	yes
#Foam insulation?	no	no	yes	no	yes	-	-	no	no	yes	no	no
Electrical pad?	0	3	2	0	0	-	-	0	0	0	0	
Other holes?	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	no
Window caulked (m)	10	23	10	4	7	5	-	5	5	10	15	14
Door caulking (m)	0	0	10	0	5	-	-	0	30	5	3	3
Window "V" type (m)	0	5	6	0	5	0	-	0	0	27	10	8
Door "V" type (m)	0	0	4	0	5	-	-	0	0	5	5	0
Spring weather-stripping (m)	10	5	20	10	14	-	-	5	0	10	10	10
Other caulking (m)	14	14	n/a	0	5	-	-	0	23	3	0	3

Note: the symbol # means "number".

APPENDIX D

HEATING COSTS COMPARISON FOR THE FALLS OF 1983 AND 1984

Objective of the analysis

In an attempt to see if the retrofitting of the selected houses had an immediate impact on their energy consumption, their heating costs for the training duration (Sept-Dec 1984) were compared to those of non-winterized houses.

Methodology

Two steps were used to compare the energy consumptions.

1- To evaluate the change of weather between fall 1983 and fall 1984, the heating costs of a group of non-winterized houses (called standard) were compared.

The ration $\frac{\text{standard cost 84}}{\text{standard cost 85}} = S$, was used as indicator

of the temperatures differences

2- To evaluate the impact of winterization on the selected houses, a similar ratio was calculated for the winterized houses.

theoritically, if the retrofitting had no effect whatsoever, the ratio $\frac{\text{winterized cost 84}}{\text{winterized cost 85}} = W$, should

be very close to 5.

If the retrofitting reduced the costs, the ratio W should be smaller than S.

Those two sets of calculations were repetead for both municipalities, Kangirsuk and Kuujjuaq.

Data

TABLE D-A FALL 1983-1984 HEATING COSTS - KANGIRSUK

Group	House #	Sept-Dec 1983 $	Sept-Dec 1984 $
Standard houses	101	3,672	637
	103	1,652	821
	102	2,612	1,431
	104	667	1,490
	105	2,478	1,562
	106	2,514	1,551
Total cost		12,928	7,492
Average per house		2,586	1,249
Winterized houses*	109	1,999	1,504
	113	2,214	1,560
	120	2,547	1,527
	128	N/A	901
	132	2,950	1,901
	141	2,447	952
	122	N/A	N/A
Total cost		12,157	8,353
Average per house		2,431$	1,392$

Source: SHQ heating fuel records

* the houses were retrofitted at any time during the period. this induces additional inaccuracy.

TABLE D-B FALL 1983-1984 HEATING COSTS-KUUJJUAQ

GROUP	House #	Sept-Dec 83	Sept-Dec 84	House #	Sept-Dec 83	Sept-Dec 84
	174	1,099	1,683	194	2,446	1,288
	175	1,010	762	195	1,356	2,117
	176	1,283	1,710	225	1,078	793
	177	1,443	1,145	226	1,213	795
Standard	178	2,986	2,008	227	1,986	1,958
Houses	179	407	970	228	1,776	1,363
	180	1,379	2,136	230	968	1,221
	183	658	1,159	231	1,388	1,165
	186	2,324	839	232	2,705	2,250
	193	2,168	1,290			
Total Cost					29,673	2,660
Average per house					1,562$	1,403$
	Katimavik	N/A	2,523	124	2,986	974
	76	1,946	767	125	1,517	2,426
Winterized	90	1,204	995	133	2,120	961
Houses*	106	2,191	863	184	973	942
	110	1,937	2,038	191	N/A	1,313
	123	1,535	1,041	199	N/A	1,217
Total cost					16,409	16,060
Average per house					1,823$	1,338$

Source: SHQ heating fuel records

* the houses were retrofitted at any time during the period. this induces additional inaccurary.

Results and Analysis

TABLE D-C FALL HEATING RATIOS - KANGIRSUK

Type of house	Value of Ratio (cost 1984/cost 1983)
Standard winterized	1249/2586 = 0.48= S 1392/2431 = 0.57= W

From the small value of the S ratio, we can suppose that the fall of 1984 was not as cold as the fall of 1983 in Kangirsuk.

Since W is slightly larger than S, we are forced to conclude that, from these partial numbers, there was no observable reduction of the energy consumption in the winterized houses of Kangirsuk.

TABLE D-D FALL HEATING RATIOS - KUUJJUAQ

Type of house	Value of Ratio (cost 1984/cost 1983)
Standard winterized	1403/1562 = 0.90 = S 1338/1823 = 0.73 = W

The value of S being slightly smaller than one, we may think that the fall of 1984 in Kuujjuaq was a little bit milder than the 1983 one. However, the difference is small.

The W ratio for Kuujjuaq is smaller than S. Theoritcally, one could conclude that the retrofitting activities caused the reduction of the heating costs but we recommended caution.

The analysis period is very short and the results do not correspond between Kuujjuaq and Kangirsuk. Such a discripancy should be investigated but it probably indicates more that the data is not reliable than any trend of the municipalities energy consumption.

Conclusion

It is without surprise that we have to concluded the results not significant at this moment. The heating costs will have to be compared on a longer time-frame and for the coldest part of the year, January to April.

APPENDIX E

THE KEEP TRAINING MANUAL

WRITTEN AND PRODUCED BY:

cma

CMA Chalifour, Marcotte et Associés Inc.
Conseillers en économies d'énergie

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LOUISE MILLETTE, KEEP COORDINATOR

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1. SUMMARY

The reader will find in this manual a large part of the information and skills acquired by the KEEP* trainees during the fall of 1984. At that time, the trainees were taught infiltration reduction techniques in houses, for a more efficicent use of energy in domestic heating.

The document contains some general information on heat losses and energy conservation but deals more specifically with the problems encountered in "Nouveau-Québec". The typical Inuit house of the 1970's is used as an example and, within the wide choice of existing energy conservation materials, only those used in the KEEP project are presented.

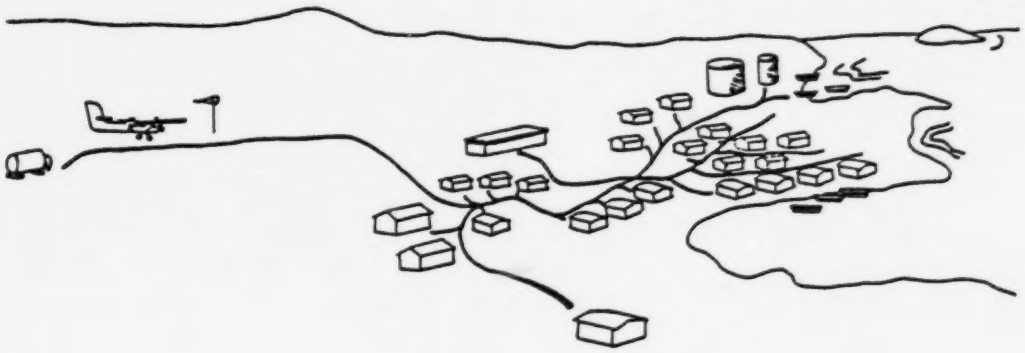
This manual should be helpful for the training program:

1° As a reminder for the first KEEP trainees;
2° As an aid for further training.

However, this book will not provide a solution to all the problems which may arise and training will always require the input of a qualified instructor.

*KEEP: Kativik Efficient Energy Program

2. INTRODUCTION



People of the North are well aware of the importance of energy, both for comfort and health.

A lot of energy is used to heat our houses, more so because they are so drafty!

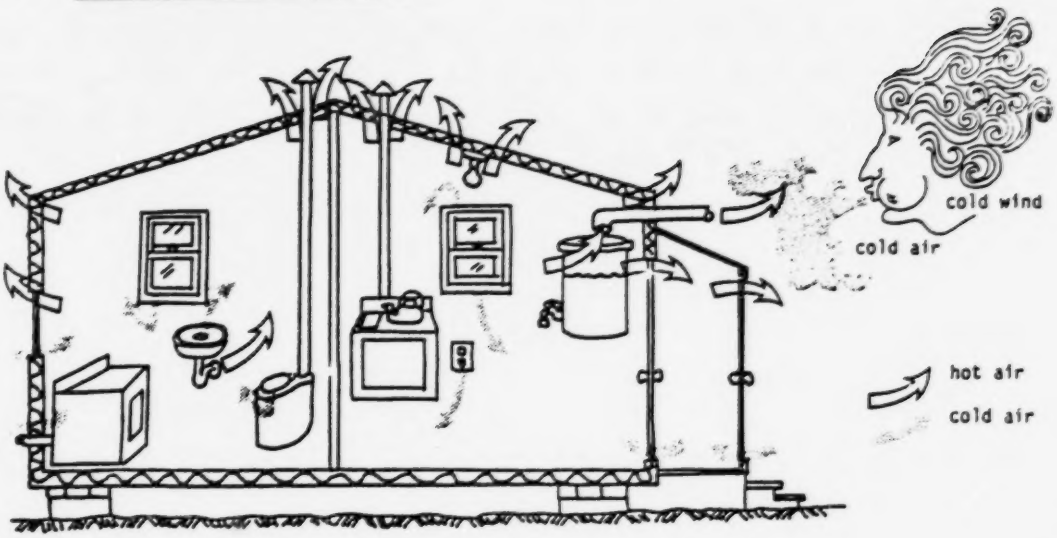
But, it is possible to make our houses warmer, not as dry, in a word more comfortable, just by controlling the cold drafts thereby reducing heat losses.

The houses will therefore be warmer and healthier to live in.

Healthier because the air inside the house will be warmer and more humid which can help tenants avoid the many ears. nose and throat problems so frequent in the North.

In addition, the houses will be safer because the furnaces and stoves won't have to run all the time to keep them warm.

3. WHERE DOES HOT AIR GO?



The work to improve the air-tightness of the house should always be done from the inside of the house, the warm side.

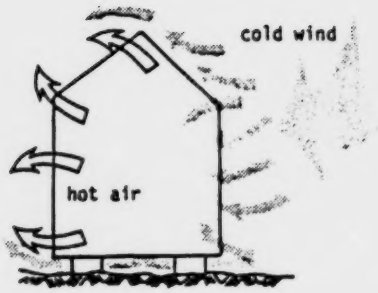
1° We need to know that:

- Where there are cracks or holes in a house, warm air can escape and cold air and snow can enter;
- Warm air rises and tries to escape near the ceiling. If you stand on a chair you will notice that it's warmer near the ceiling than near the floor;
- Wind makes the walls on the windy side colder as outside air tries to enter the house through even the smallest cracks. Warm air is pushed out the other side of the house. The cold air falls to the floor and makes it cold.
- Warm air inside the house is more humid than outside air. A lot of cold air coming in makes the house air too dry;
- Dry air is hard on the nose, throat and ears resulting in more health problems;

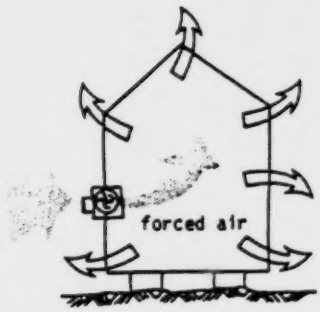
- Some humidity inside the house is good, It is better for the health and it makes the house comfortable to be in.
- Humidity comes from people breathing, from cooking, from humidifier, baths, showers and washing and drying dishes and clothes;
- Too much humidity is bad. It causes condensation on windows.

2° What must we do:

- Seal all the leaks in the house where warm air can escape through and cold air can come in.



On windy days the walls in the windy side of the house will be easy to feel the currents of air. On the opposite side, hot air will be escaping through the walls; this will be harder to feel.



With the help of a fan installed in one of the windows and a smoke generator, air will be forced out of the house through any existing holes. With the smoke generator it is easy to find the place where air is escaping.

3° What type of leaks are there in a house?

- There are those that are easy to find.
  For example: Hole in a wall;
  Broken window;
  Electrical wire under a window frame;

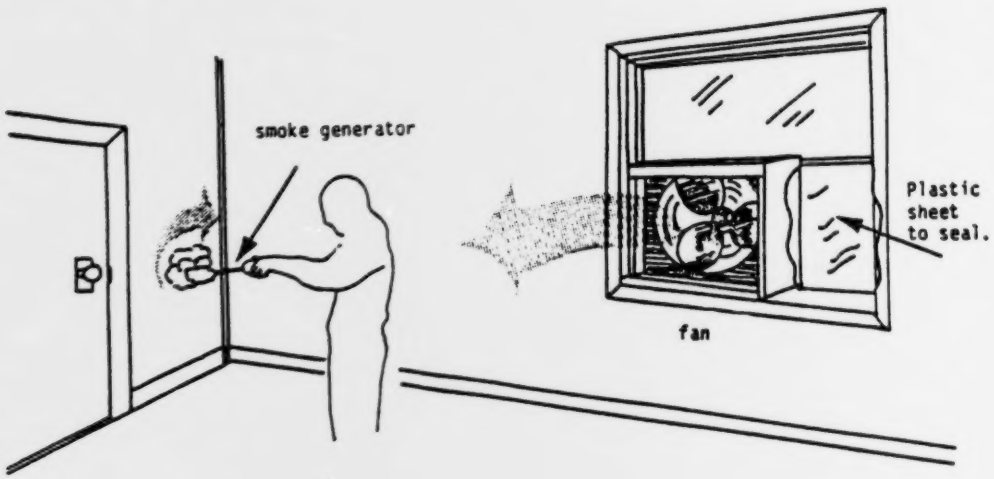
- There are less obvious cracks under a door (hidden ones).
  For example: Cracks under a window or around a door frame;
  Construction seams like wall-wall and wall-floor joints.

4° What tools do we need to find leaks?

- The experience and comments of the house tenants;
- Well trained eye of the observer;
- The hand of the observer to feel cold air coming in (it is easier if the fingers are wet).
- Fan and smoke test kit;
- Pencil and paper to take note of the leaks;

5° How to find leaks?

- Start by talking with the house occupants to find where cold air comes in;
- Walk around every room to see how serious these problems are and to find others not mentioned by the occupants;
- Search for unseen leaks by putting a wet finger near suspected leaky places. A draft through any leak will make the wet finger feel colder;
- Run a fan and smoke test;
- Remember to mark the leaks or to take notes of where the leaks are.



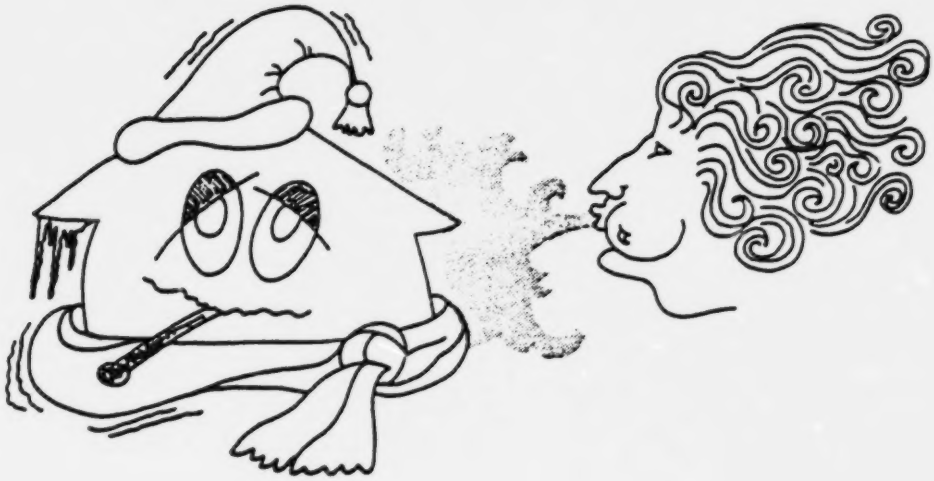
6° How to find leaks with the fan and smoke test?

- Start by shutting all the windows and outside doors (not the doors between the inside rooms);
- Open a window and securely install the fan so that it pushes outside air inside the house (you may need to remove the bottom sash to install the fan);
- Make sure that the space between the fan and the window is properly sealed with plastic and wide adhesive tape.
- Start the fan;
- Using the smoke kit as directed, make little smoke clouds in front of suspicious locations. The smoke will follow the air and if you see it rapidly go through the wall towards the outside, you have just found a leak!

7° Where are the probable leaks?

- You will find heat escaping paths near windows, doors, vents and joints like:
  - . Wall-wall;
  - . Wall-ceiling;
  - . Wall-floor*;
- Light switches, electrical outlets, around pipes, around electrical boxes, etc.;
- Checks for hints like ice formation, water stains and drafty windows.

*: On outside walls only!



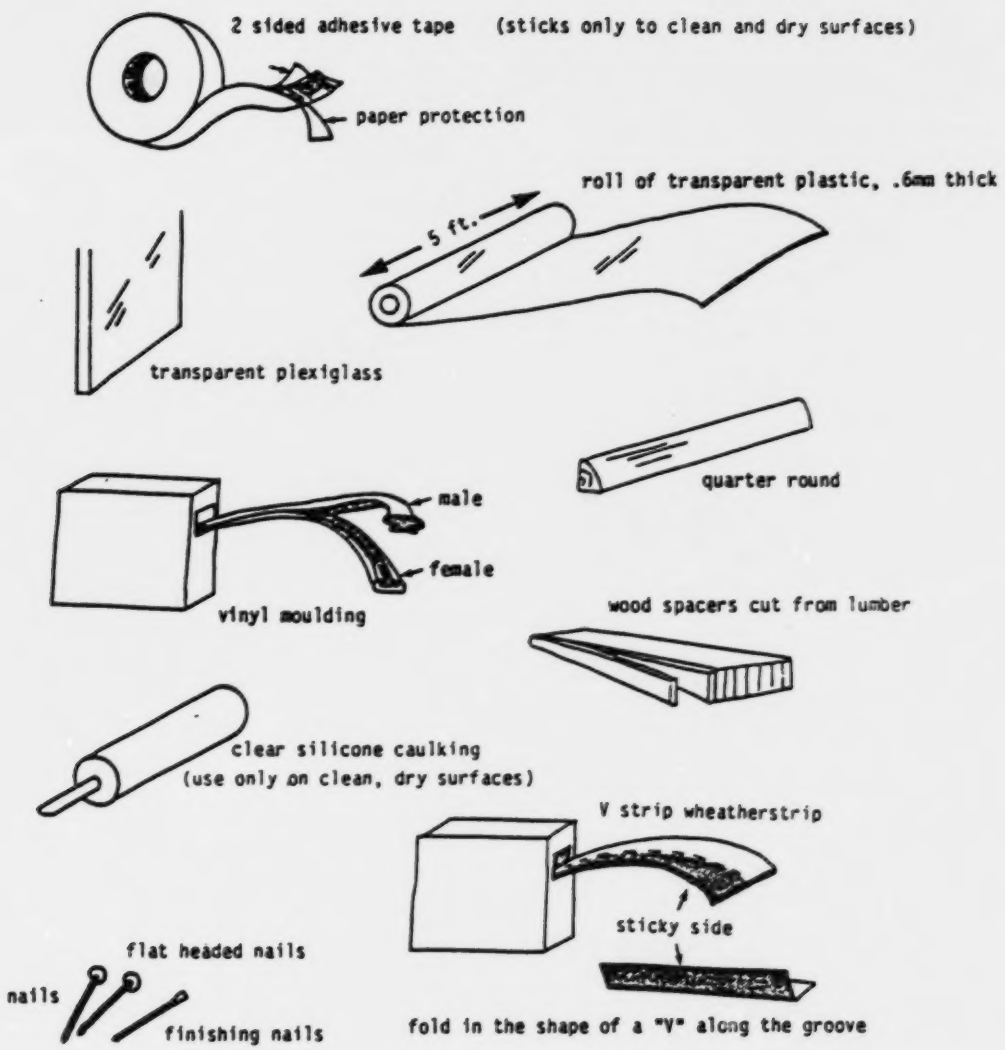
8° What are the final results expected?

- After the entire house has been inspected and note has been taken of where the leaks are, you know better where the house is losing its heat.

  In a way, you can say that the inspected house with its leaks and cold drafts, is a sick house. You acted like a house doctor, examining the house to find what problems it has!

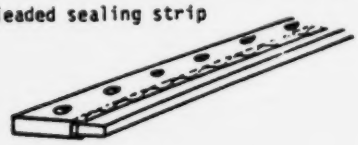
  Once you have you made the diagnosis (where the leaks are), you can "treat" the house one part at a time.

4. WHICH PRODUCTS ARE REQUIRED

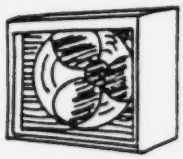


4. WHICH PRODUCTS ARE REQUIRED (continued)

flexible weatherstrip with spring leaded sealing strip



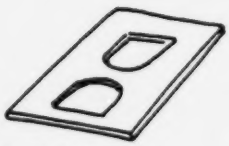
smoke generator



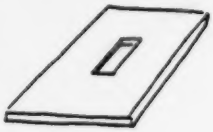
fan

rubber stripped weatherstrip for door sill

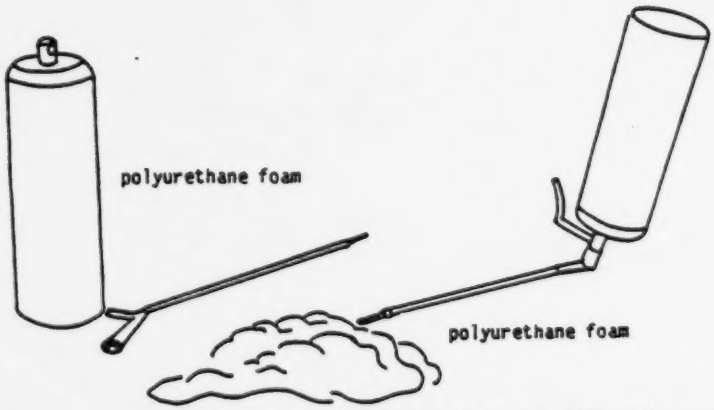
foam gasket for



electrical plug

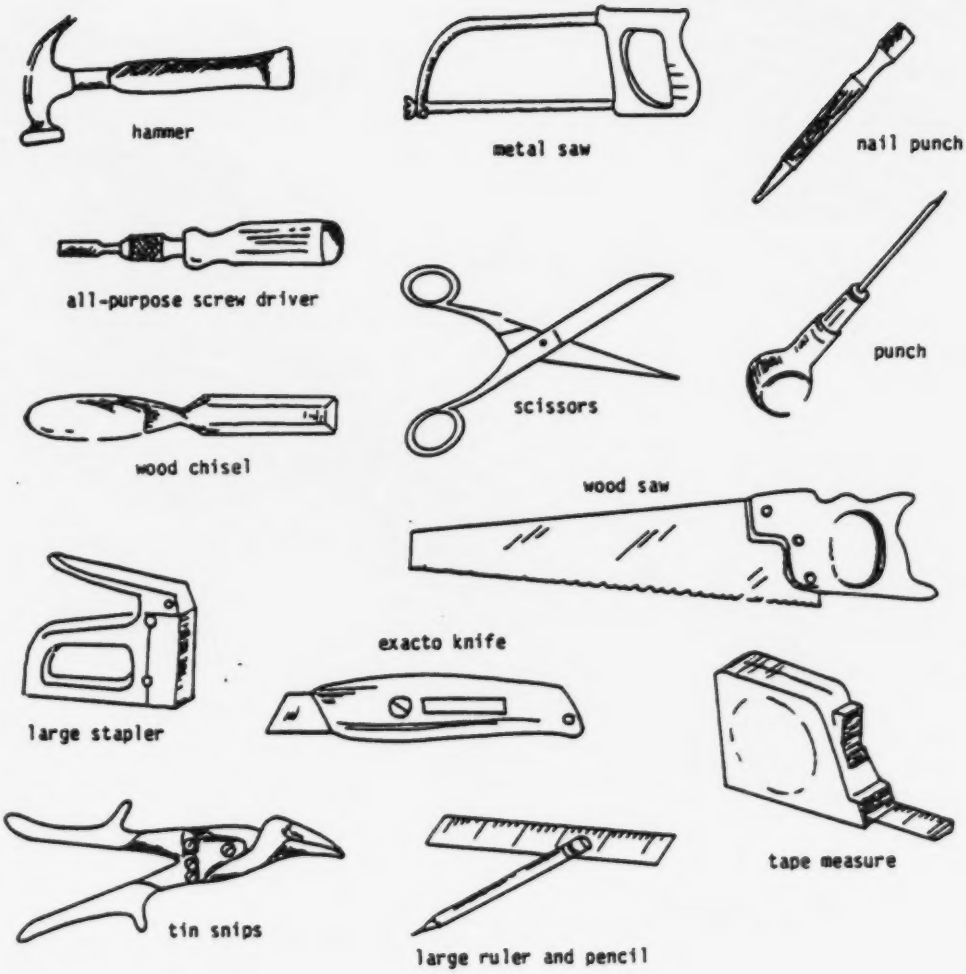


light switch

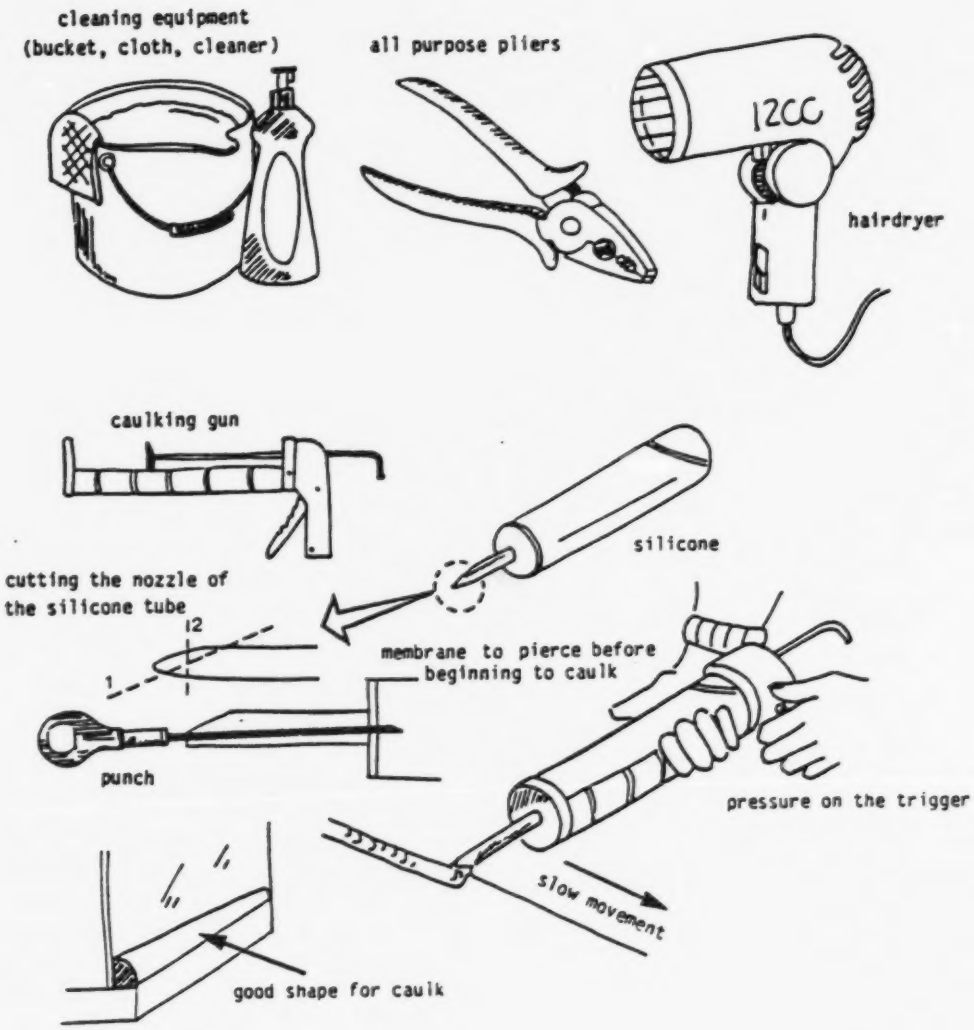


this foam expands a lot while drying so do not fill craks or holes completely (only fill them half full)

5. WHICH TOOLS WILL YOU NEED

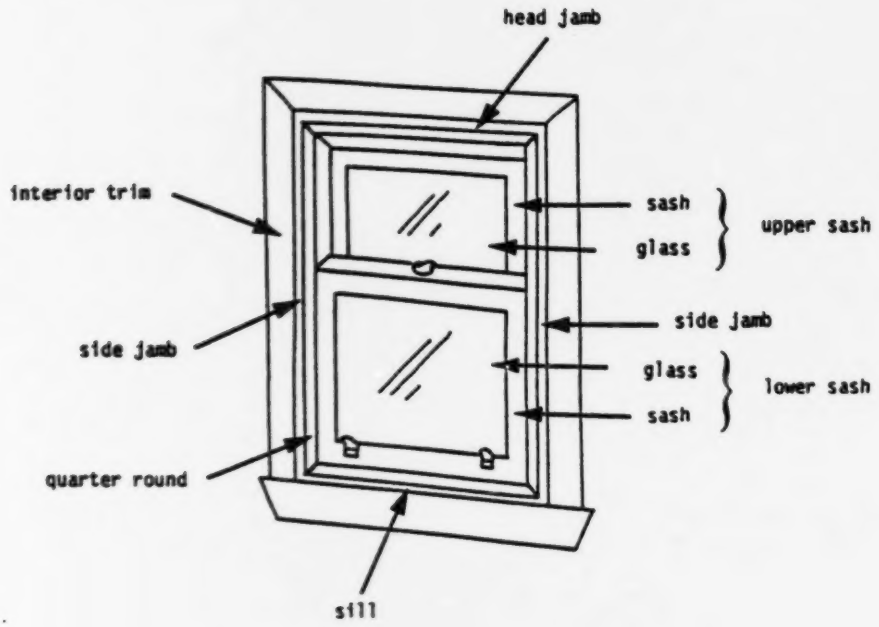


5. WHICH TOOLS WILL YOU NEED (continued)



6. HOW TO IMPROVE YOUR WINDOWS

. Here is a window



. Examine the condition of every window

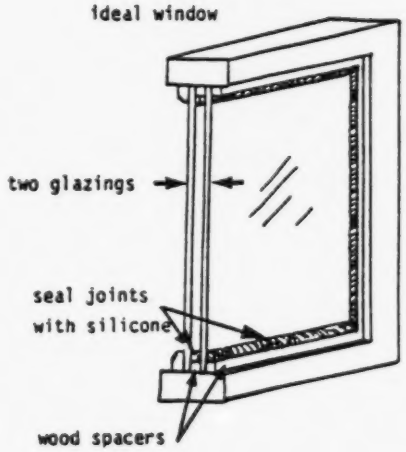
- Are there some broken parts?
- What are they?
- Take note of all missing or broken parts and their dimensions (you will want to replace them);
- For broken window pane, take the measure of the frame and cut the new pane 1/8 of an inch smaller all the way around the caulking for easy installation.
- Remember: all windows should be at least double glazed.

We are now ready to make some improvements.

. FIRST, DEAL WITH THE GLASS PANELS THEMSELVES

Tools:

ideal window

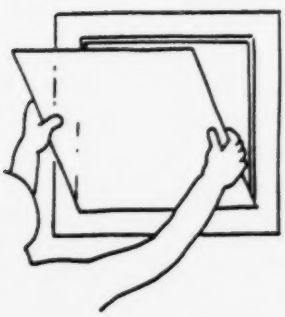


1° Remove any ice which may have accumulated on the glass (use the hair dryer to melt it).

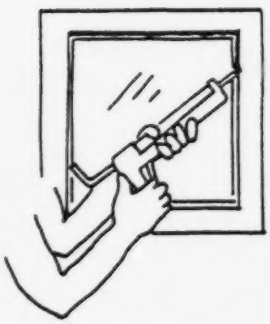
2° The glazing should be closest to the "ideal" one.

- If a glass pane is broken or missing

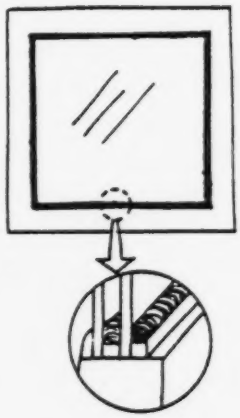
  . Remove the broken part from the window frame;
  . Clean and dry the pane and tne remaining window casing;
  . Caulk the glass-wood joints between the frame and the glass so that the wooden spacers are sitting in the caulking;
  . You can easily make wooden spacers by cutting a piece of wood in lenghts required to replace the old ones;



First remove the inner pave and clean glass and frame surfaces



Before replacing the window pave, the spaces should be well seated in the caulking



Seal the second window on the inside

. Install the new clean dry pane of glass;
. If there is enough room to fit them, put in small wood batons to hold the glass in place. If not, just caulk the joint and use the existing blocks.

- <u>If some wooden spacers are broken or missing</u>

. Remove the first glass pane from the frame;
. Clean and dry all parts;
. Replace the missing spacers setting them into the caulking and nailing them down (use small finishing nails) carefully so as not to split the wood;
. The wood spacers should be cut to fit exactly, so that all corner joints are tight;

- <u>If window panes and spacers are in good condition</u>

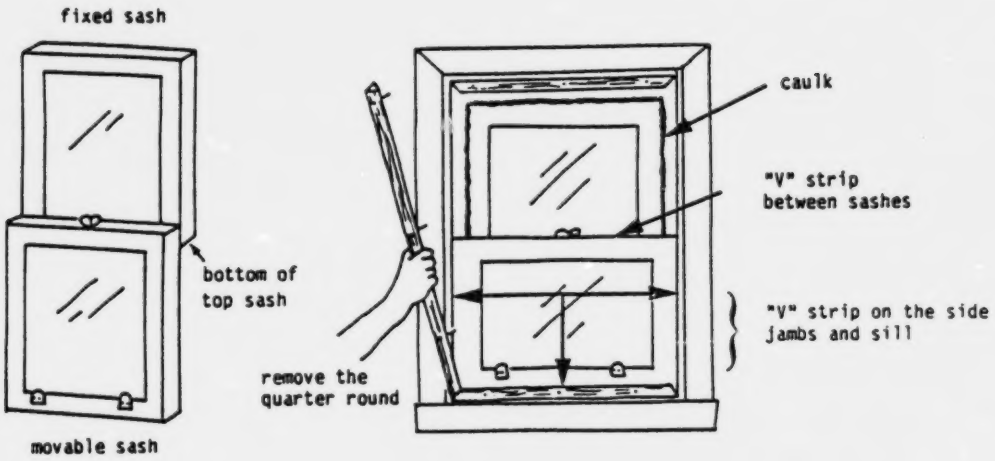
  . Clean the glass panes and sash;
  . Add caulking to the joints and if possible between the glass panes.

NOTES:

- Each sash must be checked and repaired;

- Before removing a glass pane, it may be necessary to carefully break the paint between the spacers and the sash. To do this, use the wood chisel.

. NEXT, EXAMINE THE TWO SASH-WINDOWS



At this point, the two glass panes of each sash are in good condition and perfectly sealed. Cold air must now be prevented from entering between the sash and the window sides, sill and head.

1° The top sash is usually fixed. Caulking its top and sides to the casing along with the sealing of the glass, will make it perfectly tight.

2° Tne bottom of the sash-window is movable; therefore it will need some weatherstripping. To install it, the bottom sash must come off:

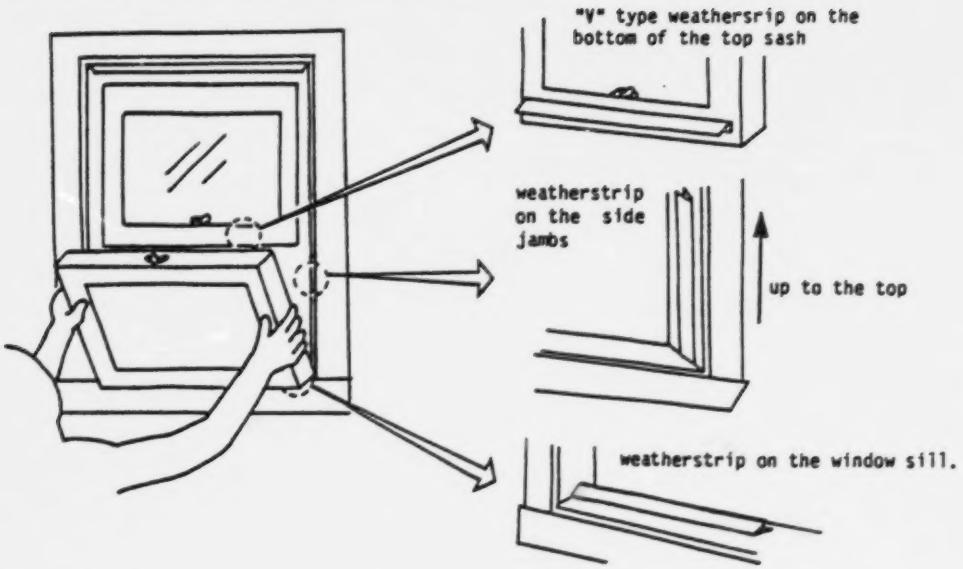
- Melt any ice around the sash with the hair dryer;
- Remove the quarter-round holding the bottom sash in place. Start at the middle of the long sides, then their ends and after, the short bottom piece. Be careful, they break easily;
- Unlock the window and remove the bottom sash.

3° Clean and dry the inside of the side jambs, the bottom sill and the bottom of the top sash;

4° Measure the four lengths (tne 2 side jambs to the top, the sill and the bottom of the top sasn) and cut the "V" type weatherstripping to fit;

5° Check the lengths of the windows to be sure they are the right length.

. NOW, INSTALL THE WEATHERSTRIPPING


"V" type weathersrip on the bottom of the top sash
weatherstrip on the side jambs
up to the top
weatherstrip on the window sill.

1° Check that all four surfaces are clean and dry;

2° Remember to fold the "V" so that the protective paper is on the outside of the fold, before removing the protective paper;

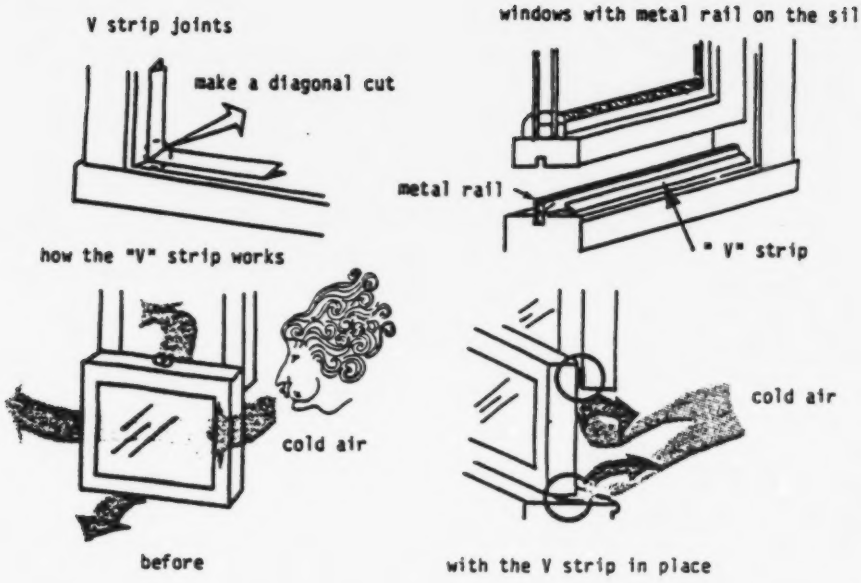
3° Start at the bottom of the top sash, with the opening of the "V" facing to where the cold will try to come in (in this case the bottom);

4° Install the side strips, "V" opening away from you towards the oustside of the house;

5° Make sure that the "V" is neatly opened and tightly glued in place. (Where they meet, they should be cut on a diagonal so that they don't interfere with each other);

6° Put back the bottom sash making sure the "V"'s are neatly folded and nail back the quarter round. Make sure the window opens easily not too tight, but not loose.

NOTE: If some old metal "V" is already on the sides as weatherstripping, it will have to be removed before being replaced by the more efficient vinyl V-strip.



Sometimes, the bottom sash will close on a metal rail.

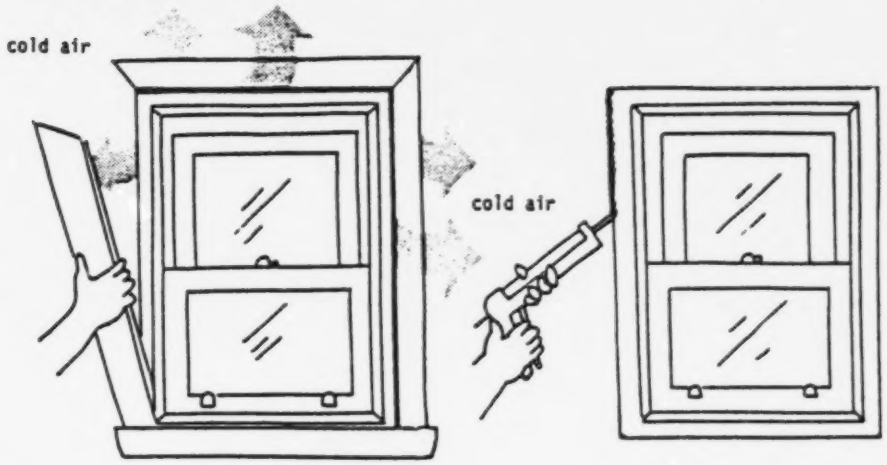
If so: 1° Clean and dry the window sill, as before;

2° The "V" weatherstrip of the bottom will go on the sill, on the interior side of the metal rail. Then, any cold air passing beyond that metal rail will get caught in the "V".

3° The "V" strips must be cut to fit well to stop the leaks as much as possible;

4° If it happens that the weatherstripping gets improperly folded, it has to be replaced.

. LOOK FOR HIDDEN OR NOT AS OBVIOUS LEAKS



Cold air can enter through cracks between the wall and window frame, under the casings.

It is necesary to caulk this crack all around the window.

Remember that the heat will also escape through hidden cracks and holes.

1° Remove the trim around the window, starting in the middle and the longer side pieces, using the wood chisel. You will see the joints between the wall and the window casing itself;

2° Clean and dry this part of the wall that was hidden by the trim;

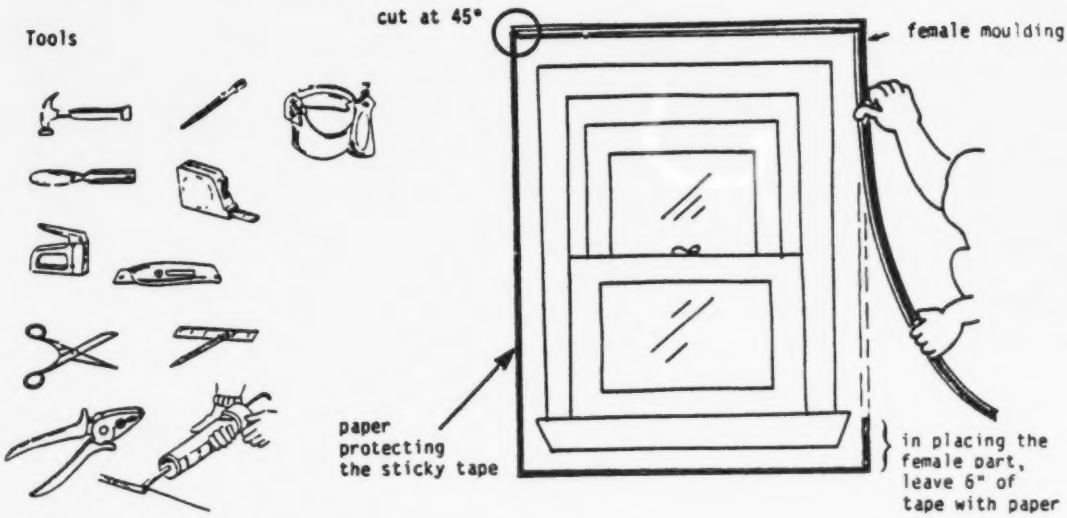
3° Caulk the cracks between the window frame or casing and wall or use polyurethane foam if the cracks are wider than the tip of the caulking tube;

4° Put back the trim.

The window is now as tight as possible. You can check by using the smoke and fan test again.

However. there may still be a few leaks left because it is difficult to seal all joints perfectly. The window can be improved further by installing a plastic storm window.

HOW TO INSTALL A PLASTIC STORM WINDOW ON THE INSIDE



Before installing a plastic storm window from the inside, always make sure the house tenant agrees because it will then be impossible to open the window without removing the plastic.

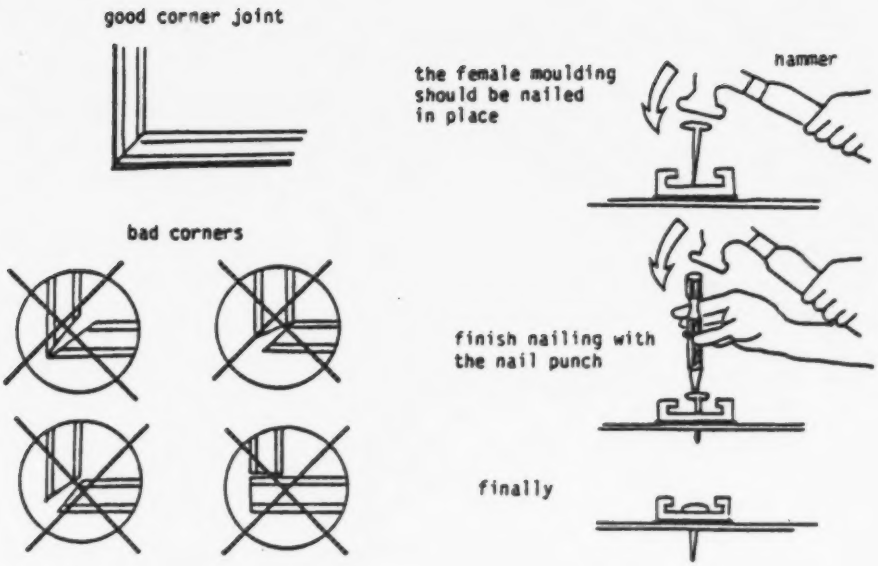
1° Clean and dry a 6 inch wide strip of wall around the trim, make sure that there are no nails or other objects that can damage the plastic;

2° Draw a line (with a pencil) at approximately two inches all around the trim;

3° Measure and cut four lengths of two sided adhesive tape to fit along these lines;

4° Remove the protective paper on only one side and install the tape on the line you just drew;

5° Make sure the tape sticks firmly and the joints are tight;



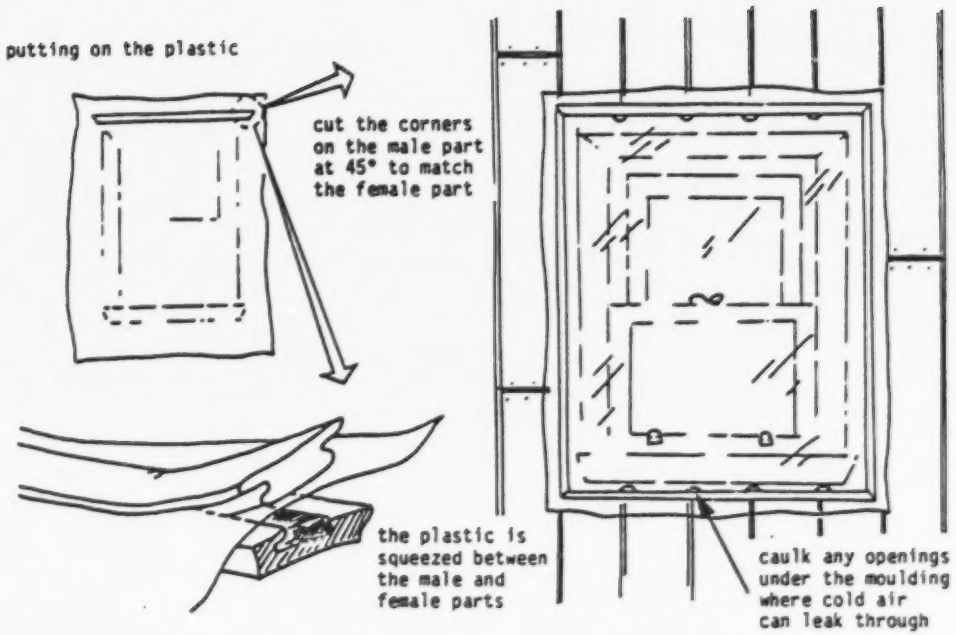
6° Use the exacto knife to cut the four strips of the two-part vinyl moulding three inches longer than needed.

7° Separate the male and female parts;

8° First, cut one end of the female part at a 45° angle then install the top female part on the wall. Remove the top protective paper from the tape only to 6 inches from the other end. (This will allow a non-sticking section for cutting the second end to fit);

9° Make sure you make a good fitting 45° angle at the second end. (Cut directly on the wall after first putting a piece of wood under the end to avoid cutting the tape).

10° Install the female moulding on the sides and bottom the same way;


putting on the plastic
cut the corners on the male part at 45° to match the female part
the plastic is squeezed between the male and female parts
caulk any openings under the moulding where cold air can leak through

11° Make the corner angles as well as possible because poor corners will cause leakage;

12° Now that all the corners are fitted, remove the remaining pieces of tape and stick the female moulding all the way (note that tne mouldings were left loose on the last 6 inches of each corner);

13° The female parts now have to be nailed for extra solidity. A T-25 stapler can be used but, on the pre-finished surfaces, use flat-headed nails. The nails can be put in best with a hammer and nail punch.

14° Caulk the corners of the moulding and any other places where air can leak under it. (For example, the grooves of pre-finished panels);

15° Now cut the clear plastic from the roll. Make it at least four inches larger than the moulding, in both directions;

16° Take off the protective paper;

17° Cut a 45° angle at one end of the male part of the moulding;

18° Start along the top, making sure there are no wrinkles and that the top is squared;

19° Install the plastic by catching it between the interlocking male and female parts of the moulding;

20° To protect the female section on the wall, cut the other end of the male part to fit on the wall by putting a piece of wood under it to avoid making a hole in the plastic;

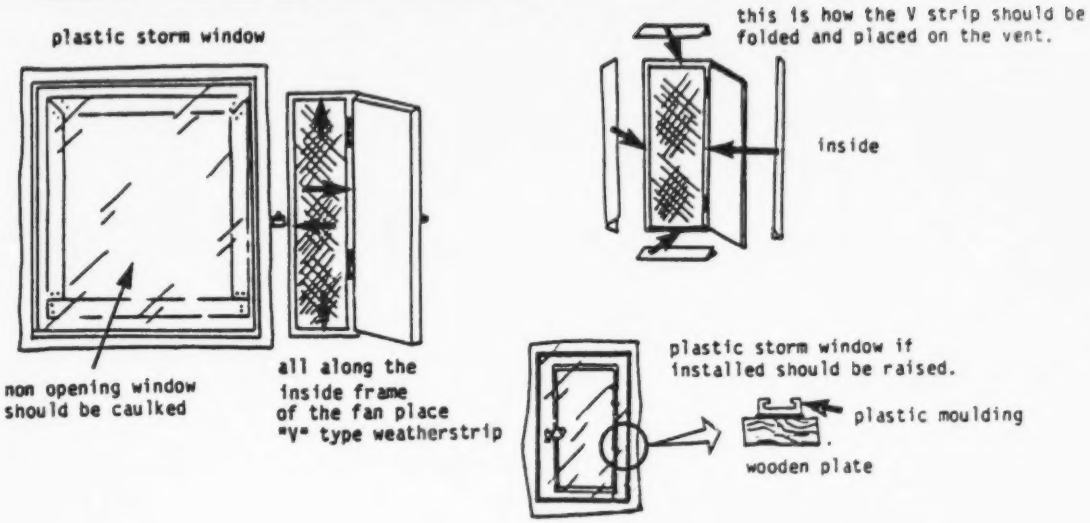
21° Do the same for the sides and bottom. Make sure that you pull the plastic sheet evenly;

22° When all the male parts are in position, and the plastic is tight, cut off the excess plastic two inches from the moulding all around.

Any cold air that might still find its way past the window will now be stopped by the plastic.

You will probably note that the plastic will inflate when the wind is blowing on this side of the house.

WHAT ABOUT WINDOWS THAT DON T OPEN?


plastic storm window
non opening window should be caulked
all along the inside frame of the fan place "V" type weatherstrip
this is how the V strip should be folded and placed on the vent.
inside
plastic storm window if installed should be raised.
plastic moulding
wooden plate

1° Check the condition of the glass panes and repair any broken ones;

2° If there are leaks around the panes, remove the first pane and the spacers, clean and dry the surfaces, and re-assemble the window, caulking the joints;

3° Check for leaks under the trim, between the window and the wall as explained for the sash-windows;

4° Add a plastic storm window, if desired, for better efficiency in stopping the cold air from entering;

5° If there is an aeration vent in the window or in the wall:

- Melt any ice with the hair dryer;
- Clean and dry the inside frame;
- Install "V" type weatherstripping all around the inside frame of the opening;

- Remember that the open part of the V faces outside;
- If the tenants agree, you can install a storm window over the inside of the vent but you may need to use pieces of wood to bring the frame and plastic out from the wall so that the plastic doesn't catch in the hinges or the handle of the vent door.
- In this case, it will be necessary to seal the wooden spacers and the wall on which they lean.

. WINDOW CHECK LIST

1. Measure all the dimensions for broken or missing glass panes or wood parts (quarter-round, spacers);

2. Cut the windows 1/8" smaller than the opening;

3. Make sure that the window sash is clean and dry before putting in new spacers and caulking;

4. Always caulk before putting a spacer in;

5. Caulk all leaks between the glass pane and the window sash;

6. The top sash must be caulked on the top and two sides if it is fixed;

7. The bottom sash must have "V" type weatherstripping, with the open part of the V facing the cold side;

8. Caulking must be applied in the leaky joints under the trim.

9. A plastic storm window can be added for extra air tightness;

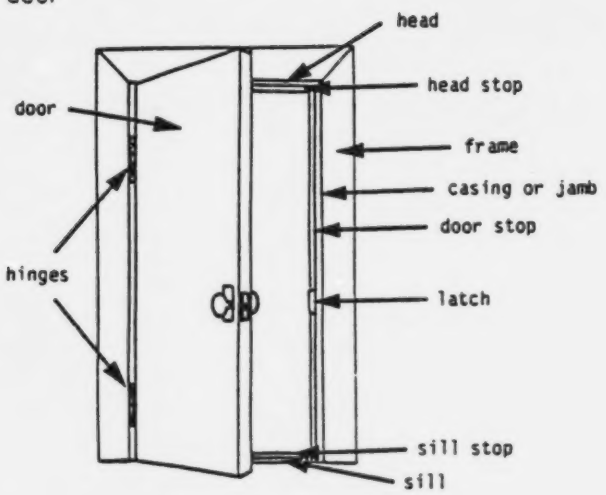
10. Windows that don't open must be caulked and can have a storm window added inside. Their vents must be weatherstripped and can also be protected by an inside storm window;

11. Never paint weatherstripping, foam and rubber can be ruined.

NOTE: A plexiglass pane can be added on the outside of the window but it must be held in place by a wood frame and not caulked.

7. HOW TO IMPROVE YOUR DOORS

. Here is a door



Examine the condition of the doors

From our point of view, the most important doors are those that open directly into the inside of the house, the "warmer" doors where the leaks are most important.

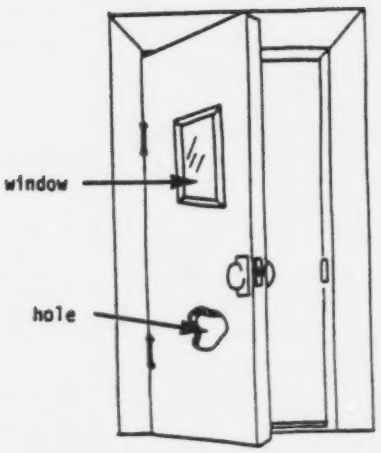
Therefore, if you have one or two porches on your house, first you should work on the inside (or warm) door, then if you can, try to repair the outer doors.

- Take note of the broken or missing parts, either on the door itself or on the door jamb (casing) and write down their measurements;

- If there is a window in the door, you should note the dimensions of broken or missing panes, just as you would on any other window.

IMPROVE A DOOR

Tools:

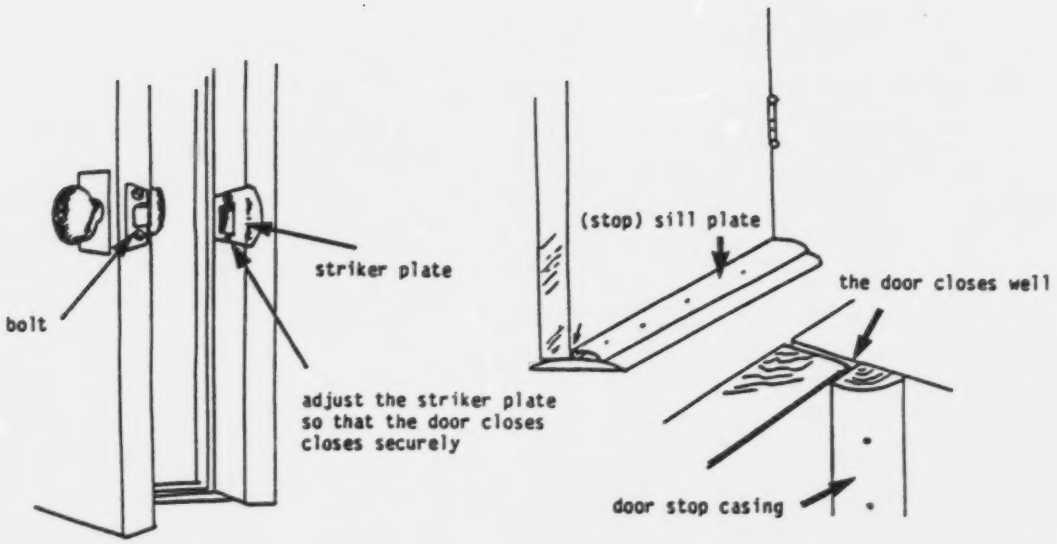


If there is a window in the door

- Fix the window just as you have been shown in the previous chapter on windows;
- Never forget to clean and dry all surfaces before you apply caulk or weatherstrip.

If there is a hole in the door

- Clean and dry the area (melt ice with hair dryer);
- If the hole is large (over 1 cm), fill it with polyurethane foam; If it is just a crack, you can fill it with caulk;
- Remember to cover the foam when it has dried because it will break down if exposed to light. Paint it with good quality paint or cover it with a piece of wood nailed securely over the hole.



- Replace the door if it is too badly damaged to repair. You may need to call housing to help you do this.

. ADJUSTING THE DOOR*

1° Latch — Make sure that the two parts of the latch fit securely. The bolt should fit tightly into the striker plate. If the two do not make a good connection, the door will rattle or even blow open on a windy day. Then you must adjust the striker plate.

* Before adjusting, make sure that the door is of the right dimension. Otherwise, the door should be replaced

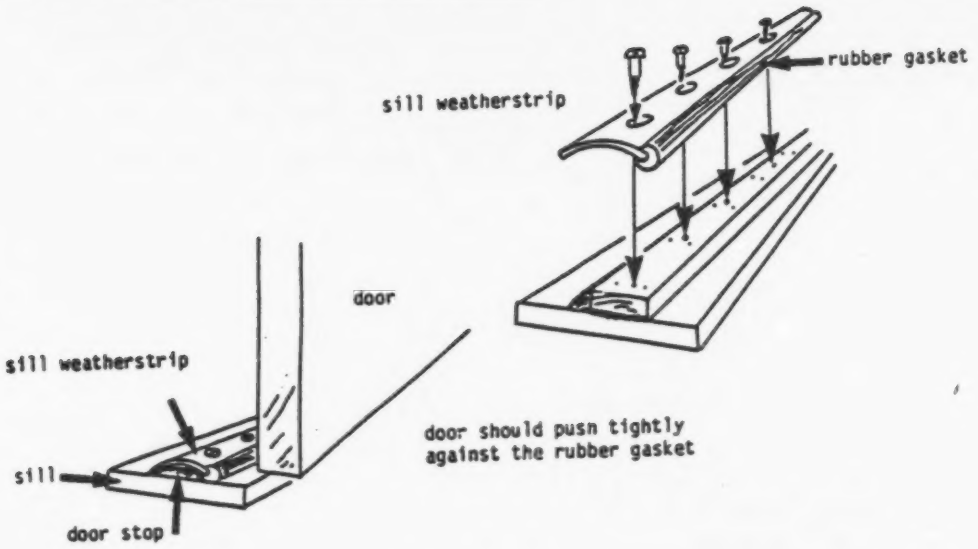
2° Door sill — The door should reach and make contact with the door-stop all the way along the bottom. If the door is too short or if the door stop is less than 2 inches wide, in order to hold the sill weatherstrip, replace the door stop.

3° Door stop — On the door knob side and top of the door, check to make sure that the door stops are in good condition and at least 1 1/2" wide in order to hold the weatherstrip. If not, they must be replaced.

4° Hinges — Make sure that the hinges are tightly screwed to both the door and the door frame. If the hinges are warped or twisted, they will have to be replaced.

5° Door — If the door won't close, plane the top or bottom depending upon where it is sticking. You will probably need to take it off its hinges to plane it properly.

. HOW TO INSTALL THE WEATHERSTRIPPING



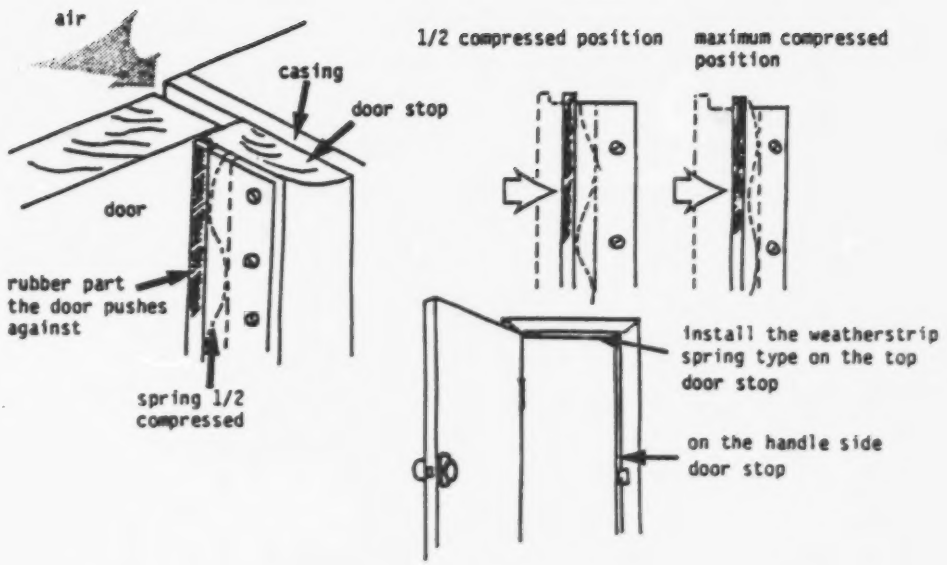
We start with the sill weatherstrip:

1° Clean and dry the door sill (remove any ice or snow);

2° Measure the length of the door sill and cut the weather-stripping to fit. Remove material from each end so that the holes stay centered. Leave the rubber gasket a bit longer on each end (about 1/2" total) so that when the door is closed, it will be a bit compressed and seal tightly. (Both the rubber gasket and the aluminum part can be cut with the hack-saw);

3° Close the door and check to make sure there is a good fit. If the door is too short and the weatherstripping slips underneath it, you must add an extra piece of wood into the door-sill stop before fixing the weatherstripping in place;

4° Screw the sill weatherstrip in place, when the door is closed it will push against and compress the rubber gasket.



The spring type door weatherstripping comes in package of three lengths. We use only two per door saving one.

We continue with the top part:

(Don't forget to clean and dry the surface before applying the weatherstripping).

1° Take the shortest of the 3 pieces of weatherstrip. Measure the length of the top of the door and cut this short piece to fit. (Use the hack-saw for everything but for the spring, you will need the tin snips);

2° Close the door and work on the outside;

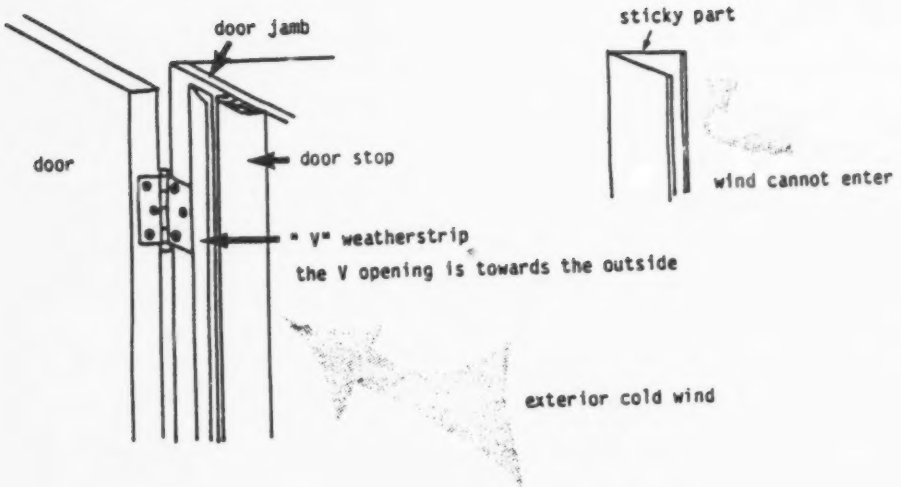
3° Install the weatherstripping along the top door stop so that the rubber part is pushed in half as far as it can possibly go.

4° Once you have got the weatherstripping where you want it, mark the location of the screw holes with the punch;

5° Now the weatherstripping can be screwed into place. Close the door to make sure that it seals well against the door.

Follow the same steps on the door-knob side

Cut the metal spring slightly shorter than the measured length. (1/16 -1/8"). Compressed, it will work more efficiently.



On the hinged side

You should install "V" type weatherstripping. It is low cost and does a great job.

1° As always, carefully clean and dry the area you will be working on;

2° Measure the length of the hinged side of the door. Cut the "V" weatherstrip to fit so that it runs from the top to the bottom;

3° Place the weatherstrip so that the opening of the V is towards the outside;

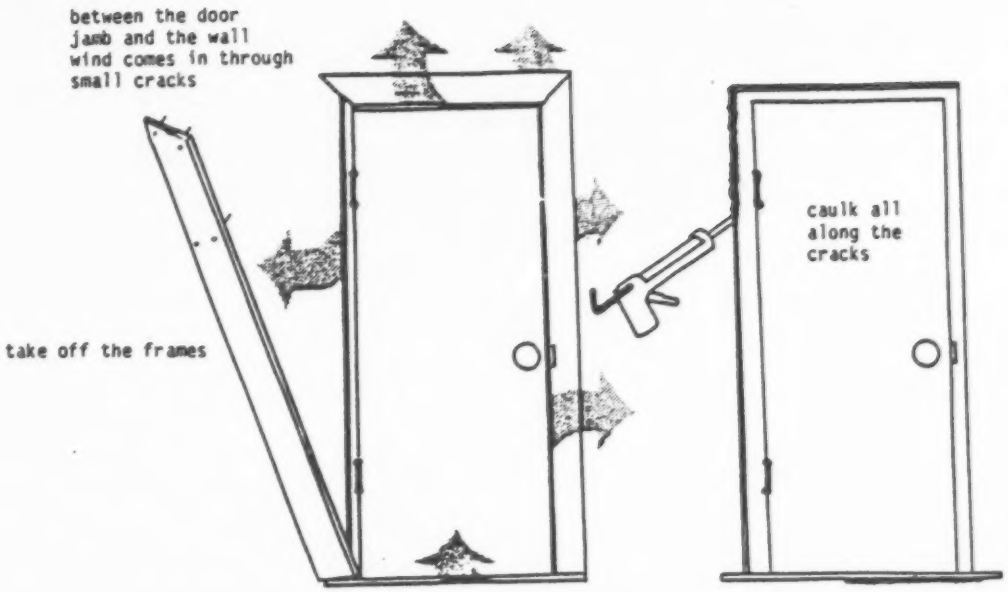
4° Fold the strip in half along its length and remove the protective paper. The sticky part should be on the outside;

5° Place the sticky side on the hinge-side door jamb near the door stop as shown in the picture. Make sure the V opening is towards the outside.

Now all the weatherstripping is in place. As a final touch, caulk the joints where the weatherstrippings meet, top to sides and sides to bottom (except where V weatherstripping meets sill weatherstripping).

Please note: The door being sealed, will be harder to close. You may have to push or pull a little harder to open and close it. But don't force it! If it is too hard to close, there is probably something wrong somewhere and you should check to see where the problem lies.

You may hear some cracking sounds at first. Don't worry this is normal. Also, never paint any weatherstripping, of any kind.



. Under the door frame

1° Using the wood chisel and starting with the longer pieces, carefully remove the door frame;

2° Remember to start with a middle nail and finish with the end nails;

3° Clean and dry the strip of wall that was under the frame;

4° Between the door jambs and the wall, and also between the head and wall and under the door sill, small cracks may be caulked. For larger ones you will need to use foam;

5° Replace the frame (change any broken pieces).

. DOOR CHECK LIST

1. Take the dimensions of any broken or missing parts of the door (glass pane, door stops);

2. Caulk the window, if there is one;

3. Fill any holes in the door or replace the door;

4. Adjust the door (latch, sill, door stops, hinges, door itself);

5. Install spring-type weatherstripping on the latch side and the top side of the door casing:
   - Clean and dry all surfaces;
   - Compress the rubber gasket half its maximum;
   - Cut the spring a little shorter;
   - Work on the outside of the door.

6. You save a length of weatherstripping per pack;

7. An aluminium sill weatherstrip is used for the door-sill. The rubber is cut slightly longer and compressed;

8. Check that the door pushes against all the length of the rubber, missing it or passing over it without touching;

9. On the hinge side, install "V" type weatherstrip;

10. The opening of the "V" type weatherstripping is towards the outside;

11. Caulk both ends of the door sill plus the corner joints of the spring weatherstripping;

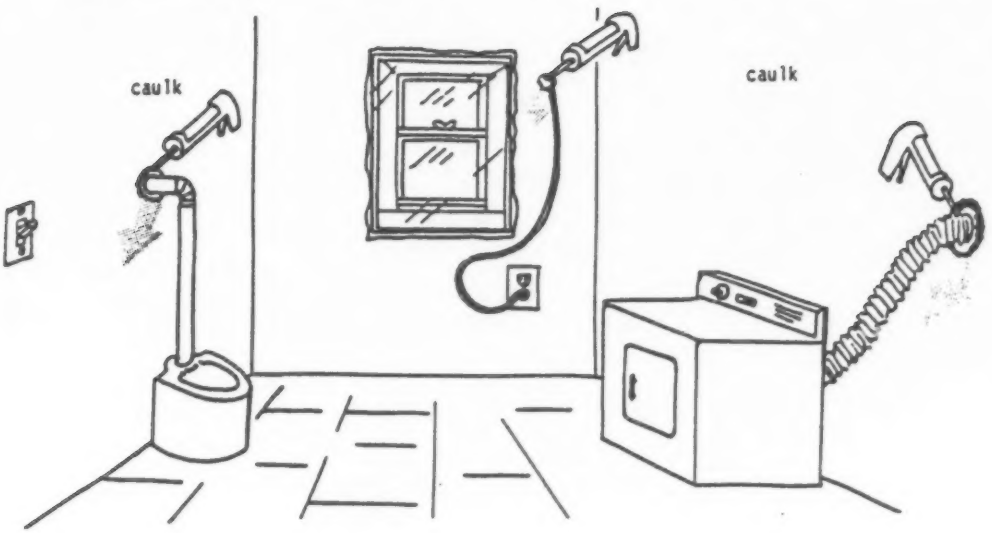
12. Never paint any type of weatherstripping;

13. Replace any damaged weatherstripping, (check them several times a year);

14. Make sure when you close sealed doors that they latch securely. Now that they are tighter, they are more difficult to close.

15. Check several times a year that the weatherstripping contacts the door at all points.

8. HOW TO PLUG OTHER LEAKS



1° Around pipes (dryer, oven, honey bucket vent, drain):

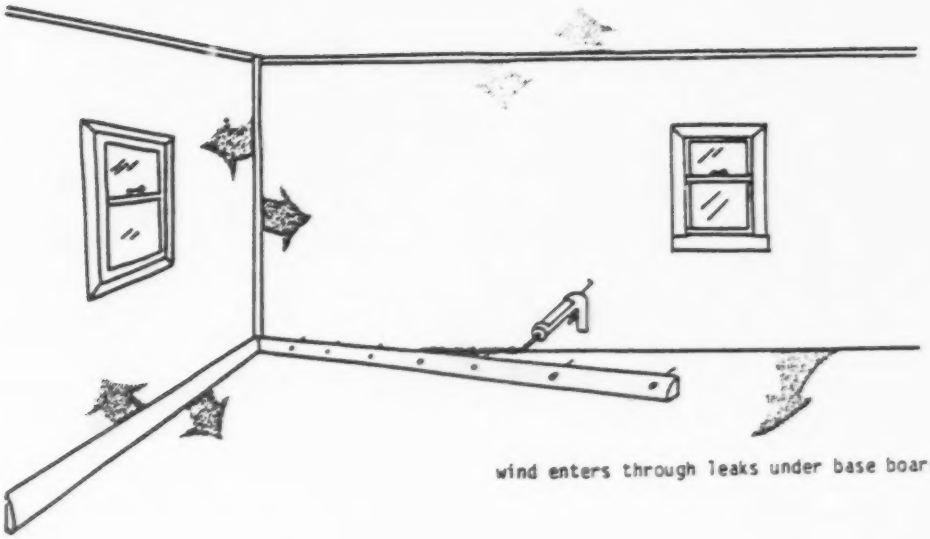
- Caulk small cracks, put polyurethane foam on the inside of larger ones;

2° Light switches and electrical outlets:

- Use specially shaped insulating mats that you put under the panel;

3° Other leaks, for example, holes in the wall for electrical extension cord:

- If it goes through a wall, staple it to the wall, inside and out so it won't wave, then plug the hole with foam or caulk; remember to cover the foam;
- Ventilation holes should be filled with fiberglass insulation;
- All other openings should be blocked and well insulated.

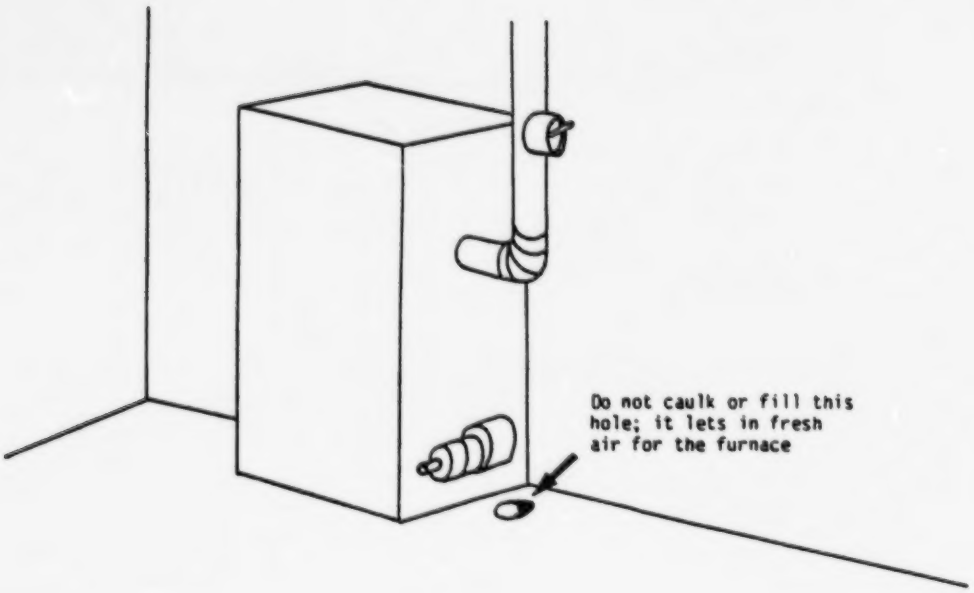


wind enters through leaks under base boards

4° Construction seams: Wall-floor, wall-wall, wall-ceiling (outside walls only);

- Remove quarter-rounds and baseboards with wood chisel (careful, they break easily);
- Sweep, clean and dry the area;
- Caulk the small cracks, plug the larger ones with polyurethane foam;
- Put back quarter-round and baseboards.

If you can see a plastic sheet covering the joint (it is the vapour barrier) and it looks in good shape. there is no need to caulk the joint;



5° Careful: Do not plug the hole in the floor by the furnace. It is the fresh air intake for the furnace and very important for good furnace operation;

6° If you found leaks around the main electrical box when you were testing the house:
- With a cloth, clean around it then dry;
- Caulk the wall-box joint.

There you are! You did an excellent sealing job and will no doubt find the house less drafty and warmer.

Remember that new cracks will appear with time and a good follow up will keep the house tight!

9. THINGS TO CHECK:

The house doctors have come to your house and they have fixed any broken windows and leaky doors, patched holes and filled cracks. Your house should be feeling warmer and more comfortable. There are still going to be things that you can do yourself. Here is a list of things that you should know about and practical things you can do to keep you house comfortable and warm.

WINDOWS

1. Windows are very easy to break. Now that they are tighter, they may be a little difficult to close. Be very careful not to force them. Don't let ice or snow build up in them and take care not to damage the weatherstrip.

2. During the colder months, you should keep all the windows closed. Use temporary caulk to tighten the windows that open in summer but stay closed in winter. This will help keep the house warmer, stop drafts and get rid of the problem of windows not closing properly because of snow and ice building up.

3. Lots of fresh air comes from opening doors. If you think that you need more fresh air, you can leave one window without a storm window.

4. When you close a double-sash window, always close the outside window pane first! This will stop snow and ice from building up between the inner pane and the outer frame.

5. Put temporary plastic storm windows on the inside of all the windows that will stay closed for the winter.

   If it gets torn, the plastic storm window is useless. Be sure to replace it.

6. You can always remove and store the plastic of the storm window but take special care not to lose the male part of the frame. Leaving the male in the female part is the only solution.

7. Heavy curtains on the windows will help reduce drafts and keep the house cozy. Open the curtains during the day and close them at night.

8. On sunny days, be sure to open the curtains. The sun will help to heat your house.

9. If you need to replace a glass-pane, remember to cut it 1/8" smaller than the opening.

10. Several times a year, check to make sure that windows and doors seal well. If they don't, correct the problem or ask the house doctor to help you.

DOORS

1. Keep snow shoveled away from the door. If snow drifts against the door sill, it will fall inside when the door opens and will prevent the door from closing properly.

2. Kick as much snow as you can off your boots before you go in. People coming in with snow on their boots leave snow on the doorsill. Shovel the snow away.

3. Be either in or out. Either way, keep the doors closed. Doors are like the zipper for the house's parka. When they are open, the house gets cold.

4. After a while, the rubber gasket on the doorsill will wear down. You should get a replacement gasket. They are available in the stores.

GENERAL

1. If you make new holes (like for a dryer or stove), don't forget to caulk around them.

2. As your house moves with time and climatic changes, new cracks will appear. Look for them as the house doctor showed you, they should be caulked.

   REMEMBER: CAULKING PRODUCTS, ESPECIALLY POLYURETHANE FOAM, MUST NOT COME INTO CONTACT WITH SKIN OR CLOTHES - THEY STICK AND STAIN.

3. Any surface that is to be caulked, have foam or adhesive material applied, must be cleaned and dried first.

4. If you find any new leaks, go ahead and add caulking or foam or replace weatherstripping.

   NEVER PAINT ANY WEATHERSTRIPPING.

5. Hot air outlets have a tendency to fill up with dust. They will work better if they are cleaned regularly (never block them).

6. When you are not using the sink, keep the hole plugged with a drain plug or rag. If you hold your hand over the sink drain, you can feel the cold air coming in.

7. Remember that because your house is now less drafty, you will not need to set the temperature and the thermostat as high as before. However, indoor air temperatures will help keep humidity higher in the house. This will be healthier for your ears, nose and throat.

   The best way to increase humidity is with a humidifier. Boiling water on the stove really doesn't help very much. Too much humidity causes condensation to form on cool surfaces such as window panes. This in turn can result in rotting window sills that will then have to be replaced.